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EDITORIAL

"WHEN *I* use a word", Humpty Dumpty said in rather a scornful tone, "it means just what I choose it to mean—neither more nor less."

"The question is," said Alice, "whether you *can* make words mean so many different things."

"The question is," said Humpty Dumpty, "which is to be master—that's all."

LEWIS CARROLL

MOST writers on "intelligence" begin with a warning that we should speak not of "intelligence" but of "intelligent behaviour". Their readers, and perhaps they themselves, commonly end by assuming intelligence to be an innate ability which is the "cause" of much human behaviour. So it follows that Jane, who was *born* with a more-than-average amount of intelligence, can become a teacher; and John is backward in reading *because* he has relatively little intelligence.

The word "intelligence" means many things to many people. Following Hebb, Professor Vernon has distinguished clearly between the hypothetical innate potentiality for intelligence (intelligence A) and the intelligence which we may observe and measure by means of tests (intelligence B). And if we ask, "What do we know about 'intelligence' as 'innate potentiality'?" his answer is, in effect, "We can never directly observe or measure it; and if we could, the measures would not be as useful as those we at present obtain."

Since this is now becoming more generally appreciated, the term "intelligence" is in some quarters disappearing from use and terms such as "academic aptitude" or "reasoning ability" are taking its place. In so far as we tend, in everyday usage, to confuse measured intelligence with innate potentiality, it may well be useful to drop the term "intelligence" as applied to tests and retain it, if we are so inclined, for the hypothetical innate component of test results.

Humpty Dumpty, however, has some justification—the change of name means little so long as we are masters of the words. Certainly it makes no difference, in itself, to our use of tests. On the other hand, if a change of name helps us to clarify our ideas, it may make a difference to our interpretation of the results we obtain—provided that we remain masters of the new names.

The danger is that the new names may quickly come to have the same confused connotations as the old, in which case we have gained nothing. The history of psychology is full of words which initially referred to functions and ended as the names of entities that were causes of behaviour; "faculties" are the classic example, and doubtless some would add "mind" itself. If the new terms are assumed to refer to some inborn and fixed potentiality which can be measured, they in turn will come to stand for *causes* of success and failure. The difference between measured intelligence and attainment, asserts Professor Vernon, "is a matter of degree rather than of kind"; so we may no more say that this intelligence causes attainment than we may say that attainment causes intelligence.

This may make a considerable difference to our attitude to Jane and John. If we accept the argument, we simply do not know how much inborn intellectual potentiality Jane possesses—we merely know how much she has developed up to the present time; and it is nonsense to say that John's backwardness in reading is caused by his low intelligence (as observed or measured by a test). Further, we should not draw the "fatalistic conclusion" that little can be done about John. Professor Vernon himself has produced evidence that good schooling can raise the level of "verbal intelligence"; and it is a truism that if we decide a child is irrevocably dull, there is a greater chance that he will remain dull. The estimate of John's intelligence is an estimate of his general intellectual level at the moment; it provides no evidence as to whether or not this level could be higher. The implication is that, above all things, we should have faith in John's ability to improve, we should give him continual encouragement, and we should teach him as well as we know how.

It must, however, be acknowledged that we may do harm rather than good if we expect of John more than lies within his abilities at the moment. Failure and discouragement will effectively prevent any improvement in his intelligence, verbal or otherwise. With this in mind, some would maintain that an assessment of his present intellectual level would warn us not to expect too much of him in the near future; perhaps we shall never be able to expect much of him.

If Jane and John are typical of the higher I.Q. and lower I.Q. child respectively, then, on a reading test, we are more likely to find Jane rather than John failing to read "up to her mental age". This problem has been much discussed during the last two years: it is an odd conclusion that more clever than dull children fail to do as well as they could in school. Both Professor Vernon and Mr

Phillips show how this is an artefact of our usual method of estimating retardation.

Junior schools and remedial centres constantly have to decide whether a child is retarded, and the problem is no less acute in the secondary modern school. A common criterion of retardation is a difference of two years between mental age and attainment age. Professor Vernon insists that it is necessary to have a clinical study of each child. Mr Phillips makes the same recommendation, shows the fallacy of the "mental-age" method, and suggests that, in so far as tests are employed in diagnosis, the "regression" method should always be used.

Both of these articles are symptomatic of the general movement away from any rigidity in our approach to children, and from any feeling of hopeless inevitability when we find them unable to learn as quickly as we wish. The corollary is that we should pay more attention to the ways in which children develop their abilities. Mr Williams' article, provoked by Mr Flavell's contribution on the teaching of arithmetic, is typical of the recent interest in learning and motivation. We are still very ignorant of the manner in which little children learn our number system. As adults, often unaware that a number system is possible except to a base of ten, we are blind to the complications facing the infant. Mr Williams believes, with most teachers, that if we can improve our methods of teaching we can perhaps help children to learn arithmetical ideas which otherwise would escape them. He describes an attempt to do this with educationally sub-normal children—who, as Professor Vernon points out, should not all be regarded as doomed to remain educationally sub-normal throughout their school careers.

More work of this kind is needed to determine under what conditions and by what means children's intellectual abilities—be they intelligence, attainment, or something between—may be developed. It has frequently been assumed that the study of science develops powers of observation and logical thinking; and Dr Wrigley shows that many teachers (at least in Ireland) are of this opinion still. There is, however, no evidence that the skills developed by a training in science are automatically transferred to other subjects. On the contrary, there have recently been complaints from industrialists that the scientists produced by our universities have specialised to the extent that, although excellent research workers, they are unfitted for executive posts. In effect, the complaint is that too much science has dulled some of their mental abilities. A solution, equally necessary in arts subjects, to such over-specialisation, may lie in the General Studies examination advocated by Dr Templeman.

Our problem at the moment is to produce not merely more scientists, but scientists who are not narrow specialists. Dr Templeman's argument will certainly be heard again during the next few years. Various attempts are being made in the universities (and not only at North Staffordshire) to provide a broader education in science faculties; and it even has been known for science to be introduced into arts faculties. The crux of the problem lies in the relations between school and university. It is a problem of which all parties are aware, and all desire a solution—but equally, all appear unable to act. Dr Templeman not only analyses the problem: he also describes one solution which is already being tried.

H. J. HALLWORTH

THE RELATION OF INTELLIGENCE TO EDUCATIONAL BACKWARDNESS

by PHILIP E. VERNON
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1. Introduction

Recently there has been considerable criticism of the commonly accepted view among British educational psychologists of the role of intelligence in attainments (1, 2), a view which derives largely from the pioneer work of Burt and Schonell. Intelligence is regarded as inborn mental ability, and therefore as a basic determining factor in the acquisition of attainments. Many other conditions, environmental, health, temperamental, and schooling, certainly enter into attainment, but a large proportion of educationally backward pupils are simply lacking in innate intellectual power; and the implication is that little can be done about them, apart from sending the more extreme cases to E.S.N. schools or special classes, where they can be taught better at their own level of ability. While Schonell in particular objects to this fatalistic conclusion being drawn (3), he often talks of pupils "working at 7 yr. MA level", etc.; and the literature abounds with such statements as: "If, therefore, a child's attainments age is approximately equal to his mental age, he is progressing satisfactorily" (4, 5). Many psychologists and teachers, also, directly contrast Mental Age with Educational Age and take the difference as a measure of *retardation*, which is thus distinguished from *backwardness*; or they calculate the ratio: $\frac{\text{EA}}{\text{MA}} = \frac{\text{EQ}}{\text{IQ}} = \text{AQ}$, the Achievement or Accomplishment Quotient. And they concentrate their remedial efforts on children with the lowest AQs rather than those with low EQs, since these are the cases in whom, it is supposed, remediable environmental or other handicaps to learning are operating.

The controversy in the pages of the National Foundation for Educational Research's *Bulletin*, and in the journal *Education* (Dec. 1956-March 1957) has centred around the interpretation of cases whose EA surpasses their MA, or whose AQ exceeds 100. Although, as Burt claims, they may sometimes be fewer in number than children with low AQs, yet when IQ and EQ are measured by tests so constructed as to yield normal distributions, which are also linearly related, the AQ distribution itself must tend towards symmetry. At first sight it might seem that AQs could not exceed 100, since children cannot work "above their native capacity". But it is not difficult to envisage home environment, schooling, interest and industry as being above average and therefore producing an attainment level better than that which is normal for a given mental level. Moreover, as Burt and Peel point out, attainments involve specialised talents or mental factors besides general intelligence, so that discrepancies in an upwards as well as a downwards direction are readily explicable.

2. STATISTICAL OBJECTIONS TO THE AQ

While the controversy seems, then, to have been based largely on a misunderstanding of the nature of test norms, it will nevertheless have been valuable if it enables us finally to banish the Achievement Quotient—as it has been banished in the United States long ago. Even apart from difficulties of interpretation it has at least two inescapable statistical defects. First, it is highly unreliable, just as any measure based on differences or ratios is much less reliable than the original measures from which it is derived, whenever these original measures are themselves highly correlated. To take a concrete example: if the reliabilities of MA and EA are 0·90, and their inter-correlation 0·75, then the reliability of MA-EA is only 0·60. The Probable Error of a child's IQ or EQ will be approximately 4 points, that of his AQ 8 points. Or to put it another way: if we selected the 10 most retarded children in a group of 100 on the basis of one set of intelligence and educational tests, and then applied a second parallel set of tests, we should find that only 4 of the 10 would again be diagnosed as highly retarded; the remaining 6 would be replaced by 6 others who were previously found to be only moderately retarded.

A second weakness is that both MA-EA and the AQ inevitably show far more bright than dull children to be retarded, owing to the familiar "regression to the mean". It is thus very difficult for the high IQ child to "work up to capacity" and equally difficult for the very low IQ child to work "below capacity". If we again select 10% of a group with lowest AQs, it will be found that about twice as many with IQs 115+ are included as of children with IQs 85 and under; and if the correlation between IQ and EQ drops from 0·75 to 0·60 (as when a non-verbal intelligence and a reading test are compared) the high IQ children diagnosed as retarded will outnumber the low IQ by about 4 to 1.

It should be noted, also, that it is rare for the older intelligence and attainments tests, commonly used in educational guidance, to yield strictly equal means and standard deviations in representative samples. Thus it may well happen that one intelligence test and educational battery indicate 10% as having AQs below 85, where another similar set of tests (or even the same tests in another age group) show 20%, simply because of irregularities in standardisation.

Now on psychological and sociological grounds it seems far more probable that the complex of environmental, health and temperamental factors associated with backwardness would occur in the lower than in the upper IQ ranges. Thus there should be *more* remedial opportunities with the dull than with the bright. Instead of this, psychologists who employ the AQ or MA-EA as their measure of retardation have been forced into the absurd position of regarding the average to high IQ retarded pupil as their chief problem, and so have little time to spare for the more frequently handicapped dull child. If we must have a quantitative measure of intelligence-attainment discrepancy, we should at least adopt an index that allows for regression, such as that published twenty years ago by Cureton (6). Further we should take account of test reliabilities and attach importance only to statistically significant discrepancies. According to Bennett and Doppelt (7), in only 10% of cases would the intelligence-attainment difference exceed chance expectation, when reliabilities average 0·9 and the test inter-correlation is 0·75.

Both Burt and Schonell emphasise that retardation should not be diagnosed merely from a comparison of two test scores or quotients, but from a clinical study of each individual child and his circumstances. Nevertheless one still hears of L.E.A. psychologists or teachers applying Sleight's Non-Verbal test and Schonell's Silent Reading Test A or B to a whole age-group in their area, and forthwith dubbing the most discrepant as "retarded readers".

3. PSYCHOLOGICAL INTERPRETATION

However the main concern of this article is with the interpretation of intelligence-attainment discrepancies. As shown elsewhere (8), the term intelligence is commonly used in two senses, which Hebb calls Intelligence A and Intelligence B. Intelligence A is the hypothetical genetic potentiality of the brain and central nervous system for mental development, which we can never directly observe or measure. Intelligence B is the intelligence which we observe in everyday life, and which we sample fairly effectively by our tests; it represents the actual level of cognitive development, or general efficiency of thinking, or, as Spearman and Burt have shown, the underlying common element in our reasoning, learning, conceptual and other cognitive capacities. And this is built up or acquired gradually by the child as a result of his interactions with his physical and social environment. Within our own culture the kind and amount of intellectual stimulation is sufficiently uniform among the majority of young children for genetic differences (Intelligence A) to play the major part in determining Intelligence B, according to Burt's calculations. But when environments vary more widely, as between white and negro sub-cultures in America, between secondary modern D streams and grammar school A streams, or between institutionalised and vocationally adjusted imbeciles (9), the relative influence of environment is more clearly apparent.

Burt likewise recognises this distinction between the "genotype" and the "phenotype", and allows that an intelligence test such as the Binet measures "intelligence-as-developed-by-environment". But he claims to be able to diagnose basic potentiality by taking into account teachers' judgments, the results of additional tests (presumably non-language), and information regarding the child's upbringing. Hence he still believes it possible to distinguish educational backwardness attributable to genetic from other causes (10). However, one would hesitate to recommend the practising educational psychologist or teacher to "adjust" the measured IQ in this manner. Surely he would be on much safer ground in accepting the IQ as an index of present level of all-round intellectual functioning, and to admit that he does not know how far it has been inhibited or stimulated in the past, or how much it may vary in the future.

It is equally illegitimate to regard attainments as wholly acquired, or dependent primarily on goodness of schooling. Many investigations have shown that the amount of time given to teaching a subject in different schools has little correlation with the amount acquired; and though the use of improved educational techniques can usually be shown experimentally to bring about greater gains, they never contribute more than a minor proportion of the variance in attainments. We are still much too apt to regard the learning of multiplication tables, for example, as the accretion of bits of information through repeated drilling. Certainly practice enters—just as Piaget has shown that it enters in the development of our percepts, concepts and techniques of reasoning. But for any progress in arithmetic it is equally important for children to explore and discover relations among numbers, in and out of school.

If schooling was the major factor, we would surely expect considerable fluctuations in attainment from year to year as children changed classes. There has been curiously little study of the stability of attainments in comparison with that of intelligence. However recently Blandford (11) analysed intelligence test and averaged educational test results of over 1200 children in 19 primary schools from 8+ to 11+, and actually found somewhat higher correlations between successive EQs than IQs (12). Follow-up studies of 11+ examinations suggest that greater fluctuations in attainment occur when children change school and advance to new or more complex school subjects. No doubt, also, we would find greater unevenness in progress in any one school subject, say arithmetic, than in all-round attainment. But equally we would find greater variability at any one type of intelligence test, such as reasoning problems or vocabulary, than we do in "g" (as Tyler has shown (13)).

We may conclude, then, that attainments likewise depend to a very large extent (under the fairly standardised conditions of schooling in this country) on genetic factors, including Intelligence A and the genes that underly special talents—verbal, numerical, musical, etc. They are built up cumulatively in much the same way as our intellectual capacities. The concepts of "maturation" and "readiness" are familiar to us in the beginnings of reading, but we should realise that all other attainments likewise depend as much, or more, on potentiality-developed-by-previous-experience, as on present instruction.

Clearly the distinction between Intelligence B and attainments is a matter of degree rather than of kind. Indeed there are many intermediate functions which can hardly be classified. Vocabulary often turns up both in intelligence and in attainments tests; and American educational psychologists, especially when testing for selection of college students, have abandoned *both* intelligence and attainments tests, preferring to try to measure "developed abilities", such as reasoning with mathematical, linguistic, scientific or social studies materials (14). Nevertheless a relative distinction still seems useful. Attainments refer to mental knowledge, skills and understandings which are more directly channelled by the content of the curriculum and the kind of training the school provides, and which probably depend to a greater extent on interests and on personality factors such as industry. Whereas intelligence refers to the more generalised thinking functions—all-round conceptual development, techniques of analysing, comprehending, organising, learning and problem-solving which—as Ferguson (15) points out—have crystallised out of the child's previous experience, and which have wider transfer value to new situations. These general intellectual skills are largely developed from out-of-school experiences although, as Gordon's canal-boat and other investigations have shown, their growth is inhibited if schooling is highly deficient. And although they show marked fluctuations over long periods in a minority of children, we know little about controlling them other than such vague generalities as that they are affected by the cultural level of the home and by its democratic, as contrasted with rejective or over-protective, atmosphere. In other words we cannot as yet teach children to be more intelligent to the same degree as we can teach them spelling and arithmetic. It is quite probable that first-rate schooling, which encourages intellectual exploration and keenness, does do more to stimulate and develop the mind all-round than does the mechanical instruction of bored pupils; though we have little direct evidence, and should not forget the negative findings of so many experiments on transfer.

If we accept this view, it is clearly false to regard measured intelligence as a "cause" of attainment, although both intelligence and attainment are largely "caused" by unascertainable innate potentiality. Certainly the child with IQ 120 is likely to be more educable than the one with IQ 100, and this may be because he inherits better genes. However, we do not know if the latter inference is legitimate, whereas we do know that his genes, as developed by his environment, have brought him to a higher level of mental functioning. Moreover, this level is likely to give a much better indication of probable future development over the next few years than would a true measure of his Intelligence A, if that were attainable.

Though we would naturally expect a close correspondence between Intelligence B and general attainment in a majority of cases, discrepancies are no more surprising, nor necessarily more serious, than are discrepancies between arithmetical and linguistic abilities, or between mechanical and musical abilities. However, there would seem to be some justification still for accepting verbally measured intelligence as a criterion of educability, in so far as it does usually give as good or better predictions of future attainment than does present attainment when conditions of schooling alter, as they do at

11 years. To some extent, that is, the intelligence test is fairer to the child who has been handicapped by bad home or health conditions, irregular or inefficient schooling, or maladjustment, though we should not forget that the IQ itself may be depressed by these same factors, perhaps to a lesser degree. Again we might reasonably suppose that a child who, in or out of school, has built up good thinking capacities should be able to transfer them to his English and number work more readily than number skills, say, will transfer to English. ✓

Educational psychologists frequently claim that the more intelligent, retarded, child is more responsive to treatment or special coaching than the less intelligent. There seems to be little published evidence for this; on the contrary many investigations have shown a remarkable absence of correlation between IQ and gain in attainment over a specified period (16). Perhaps the claim simply reflects the fact that the more intelligent are seldom as far below their CA in attainment as are the dull, and are therefore naturally easier to teach.

4. CONCLUSIONS

What practical conclusions can the educational psychologist draw?

1. We should either banish or else entirely re-interpret the conception of "failing to work up to potentiality". Probably *all* children are "under-functioning", in the sense that their attainment is not as good as it might be under ideal home and schooling conditions. Educationists are, of course, continually trying to improve matters, but progress is slow; thus the remedial efforts of psychologists and teachers should presumably be concentrated on the most serious cases who are likely to benefit most.

2. In general, those who are most below their age-group in attainment are the most serious cases. However, the teacher's observations should suggest that there is more hope of improvement in some very backward children than in others. The resources of the Child Guidance or Educational Clinic should then be drawn on for a more thorough study of such individual cases. Gross discrepancies in attainment in different subjects (Schonell's "specific retardation") are certainly worth attention and, as admitted above, verbal intelligence test performance may provide some indication. Investigation of school history, diagnostic testing of errors and weaknesses, assessment of home and medical factors, social and emotional adjustment, are all at least as relevant as they are in the more conventional cases of so-called retardation. ✓

3. The previous recommendation consists of theoretical sugges-

tions. But, as Pidgeon and his colleagues point out (2), experimental research should reveal precisely what characteristics of backward children (whether test scores or case-study data) are more predictive of improvability than is the AQ. Local Authority psychologists are in an excellent position to conduct such research by collecting information about children referred to them for remedial work and correlating it with gains in attainment.

4. Intelligence as a factor in educational progress should *never* be tested by non-verbal or performance tests, on the specious grounds that these provide IQs less affected by education or that they are fairer to children with reading disabilities (17). If individual testing by the WISC Verbal scale or the Terman-Merrill is not possible, then group oral tests should be used. There is clear factorial evidence that non-verbal tests measure group or specific factors of their own besides "g". Hence the fact that a child is better capable of dealing with pictures, abstract diagrams, or concrete materials than with school work is no justification for regarding him as a maladjusted case or one in special need of remedial help.

5. Intelligence tests demonstrably contribute to educational selection; but their role in the diagnosis of backwardness is less important than we have generally supposed. Another reason for "playing them down" is that teachers, administrators, parents and others are so inclined to regard them as measuring inborn ability, even when the psychologist interprets them more carefully. It is gratifying to note that Moray House, as well as the National Foundation for Educational Research, is giving up the terms "intelligence test" and "intelligence quotient".

6. Successful remedial work with many cases of backwardness should be expected to improve their IQs as well as their EQs. The conditions associated with marked changes, up or down, would be another fruitful field for research.

7. We should redouble our efforts to break down the conception of E.S.N. children as a distinct group of abnormals, who must be diagnosed by medically qualified persons, and who must spend the whole of their careers in separate schools. It may well be useful to have special schools or special classes for the most backward 5% or so of the school population, provided they can be staffed by teachers who are specially trained in teaching the very dull and backward. But we should expect more than half of this 5% to be capable of returning to the ordinary schools after a few terms. A rough calculation would suggest that about one quarter of the population falls

within this bottom 5% at *some* stage of their school careers, but that only about 1½% should be expected to stay within it throughout their schooling. These considerations imply a very different approach to backwardness and its treatment from that which we have inherited from the earlier writers on mental deficiency.

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RETARDATION AND THE USE OF TESTS

by C. J. PHILLIPS

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PREAMBLE

VIEWS as to the nature of intelligence and what is measured by intelligence tests have been in the melting pot for some time. In the field of education these controversies found a focal point in the articles on "The Relationship between Ability and Attainment" which appeared in *Bulletin No. 8* of the National Foundation for Educational Research in November 1956. The publications which followed, and the widespread debate, showed the urgent need for revision of many prevailing concepts and some educational practice. Changes of practice that are changes for the better usually follow changes of theory; and theoretical change depends upon two kinds of enquiry, logical and empirical. This article is largely concerned with a logical matter and since most of our difficulties arise from a paucity of evidence, it makes a very small contribution to the general problem. The writer endeavours to state what seems to him the irreducible minimum of concession which teachers, educational psychologists and clinicians must make to the critics of their traditional practice.

INTRODUCTION

The study of growth through infancy and childhood reveals a certain general conformity and sequence such that we can have expectations concerning the abilities of a child of any particular age. These expectations cover a wide range of activities and, within the limits of a prevailing culture and material environment, we can say of a child of a certain age that he will probably be able to spell a certain range of words, handle certain kinds of mathematical operations, observe the rules of games to a certain complexity, achieve a certain level of social independence, show certain characteristics in his drawing of a human figure, and so on. Over and above basic operations such as these there are individual differences in temperament, interests and attitudes which, although in some ways dependent for their particular manifestations upon these predictable skills, show little relationship to them when one examines large numbers of children.

Observations of children lead us to recognise two main types of deviation from average expectations. Firstly, children do not perform exactly as expected; they either surpass or fail to measure up to expectation. Secondly, abilities which generally go together do not always do so and a child may show inconsistency in his development. In the first case, the extreme failures to reach expectation give rise to the concept of "backwardness" in the educational field; in the second case, extreme failures in learning give rise to the concept of educational "retardation". This article is about retardation.

CRITERIA FOR RETARDATION

Let the following dialogue serve as an epitome of many interviews and inquiries since space does not allow quotation of an actual case study. It might be a conversation between an educational psychologist who has just talked to a P.T.A. meeting and one of his audience.

FATHER: My boy is nearly eleven years old; he'll be leaving this school in the summer, but he still can't read. I know he is not a very dull boy. He must be one of these problem children.

PSYCHOLOGIST: Some children are much slower in learning to read than others. What makes you so certain that he is not just one of the slower ones?

FATHER: He's very well developed physically. He's the tallest boy in the school.

PSYCHOLOGIST: As far as I know, children's height has nothing to do with their being able to read.

FATHER: But he works hard. He has been practising the violin for two years and he can play "The Bluebells of Scotland" perfectly.

PSYCHOLOGIST: That's very nice; but surely the fact is that most boys, even boys much younger than your son, would achieve that much if given a violin and lessons.

FATHER: And then, he's won the district chess championship.

PSYCHOLOGIST: Now that is very interesting. . . .

In making assessments of a child one attempts to say how he compares with other children of the same age and how consistent or disparate is the development within the child himself. When comparing different aspects of growth and learning it is needful to know how well these go together in the general population, and what would constitute a disparity beyond the variations which are commonly observed. In the example above three facts were given about the boy who could not read. Physical growth, we may assume, shows little consistent relationship with reading ability in the population of which this boy is a member; and so it may be rejected as irrelevant. Playing the violin and playing chess might both show some positive correlation with school learning, but the amounts of skill which the boy displayed in reading and violin-playing were not so grossly at variance that they attracted attention; the difference might occur very frequently in the population. General observation would support the view that it takes intelligence to play chess well; that chess-playing and school-learning go together on the whole; and that the discrepancy shown in the two skills was sufficiently great to occur infrequently.

If the psychologist examined the boy and found that his vocabulary, his general knowledge, and his ability to reason and to solve problems, when these were presented to him orally, were all at a level typical of his age group, or better, he would have obtained confirmatory evidence that the boy was not only showing marked failure to learn in one important area of his life, but also that this failure to read represented a significant disparity in development as compared with his progress in many other directions.

Although it has no bearing on our main thesis, it is perhaps important to digress and to emphasise that so far no hypotheses have been advanced as to why the boy has not learned to read; nor have we said what steps, if any, should be taken to teach him. On the evidence of his general ability, as shown in the samples of his skill in things other than reading, the psychologist might expect such a boy to read at, say, the level of his age group; or, admitting to the margin of error in all psychometrics, within perhaps a year more or less of this standard. But if help and advice are to be given he must enquire further and attempt to analyse the causes of this failure. Among the antecedent circumstances which are found in cases of severe reading failure are:

i. A lack of opportunity to learn.

ii. A failure to feel the need to learn, or to feel anxiety about the lack of skill.

iii. An ability to make progress in informal situations, but a marked rejection of formal learning situations.

iv. A degree of maladjustment which makes some learning too difficult.

v. A specific difficulty in dealing with visual or auditory stimuli and in learning to make correct responses to them.

In other words, there are other important predictors in the situation besides "general intelligence".

Retardation and Intelligence

However, educational psychologists, and others, attach a particular importance to the predictive power of general intelligence; and when an assessment of general intelligence is markedly higher than educational achievement, one has a condition which is usefully described as "educational retardation". The question of whether they are right in continuing to attach so much importance to this predictor is beyond the scope of this article. There is not sufficient evidence available at present to justify a complete rejection of traditional practice, which places general ability high in the hierarchy of predictors of school learning. The assumption is that one is more likely to change attitudes, to adapt instruction to particular disabilities and to relieve emotional handicaps to learning (thus, in a sense, beating the predictors), than to change general ability.

Retardation might be defined operationally in terms of a disparity in performance, beyond some conventional limit, on two kinds of tasks which have a known correlation in an appropriate population. Having regard to the unreliability of measurement, one would prefer a cluster of such disparities. Of course, it has to be established that the disparity is truly of diagnostic significance; the known correlation in the general population seems to be a necessary but not a sufficient condition for its establishment. There is no reason why one should limit the range of evidence to formal tests; but when retardation is defined by such tests, with their norms expressed in terms of "ages" or "quotients", it does not necessarily follow that there is some absolute relationship between school attainments and general intelligence, or that a child's attainment age *ought* to be equal to his mental age.

Within the class of evidence which may be labelled "general ability" there is the special class of intelligence tests. These tests have no exclusive claim to the field of relevant evidence. It takes intelligence to play chess well and the teacher who disregards the evidence of an outstanding ability of this kind in favour of an IQ of, say, 80 on a group test, makes the mistake of admitting only one class of evidence and of attributing to it greater authority and finality than it has a right to.

Intelligence tests are of many kinds and they sample many types of thinking. It is practically impossible to define them as a group by their contents. Broadly speaking the intelligence tests and the attainment tests which are used in schools are distinguished, one from the other, by the fact that the latter sample learning of a formal kind which has progressed under instruction, whilst the former sample informal learning employing material and situations to which the testee is relatively naive.

We do not expect the different kinds of behaviour sampled in intelligence tests to be equal in predictive power with regard either to educational achievement, or to anything else. Tests vary greatly in the amount of correlation which they show with school attainments. This range may be indicated roughly by the following correlation coefficients:

Tests of Intelligence	*Positive Correlation with Reading Ability*
Drawing-a-Man	·3 to ·4
Group Non-verbal	·5 to ·65
Group Verbal	·6 to ·75
Individual Tests such as Stanford-Binet and WISC	·65 to ·8

This variability makes impossible the straightforward comparison of mental ages, derived from intelligence tests, with attainment ages.

We need to ask of an intelligence test, as of any other evidence, to what extent does it go with school learning and to what extent does a particular observed difference go beyond what commonly occurs? (We are ignoring the other important aspect of prediction: changes that may be expected in time. How long is a present state of affairs likely to persist? For what period of time is an IQ valid?) It is difficult to do this with regard to the comparison of an ability like playing chess and another ability like reading, except in cases of extreme disparity, since this would involve the collection of evidence about chess-playing of the kind which we already have about reading. But it becomes at least theoretically possible to ask such questions when one is using standardised tests, since these are usually designed with the necessary statistical operations in view.

THE COMPARISON OF SCORES FROM TESTS

(*a*) *Two Methods of Comparison*

Let us suppose that we are concerned with a group of children who are 9 years of age, to whom two tests have been applied, an intelligence test and a reading attainment test. In accordance with the usual practice, the two tests have been standardised to age norms from which may be obtained intelligence and reading quotients. We shall assume that the quotients have means of 100 and standard deviations of 15 (1) and that the two sets of quotients correlate at +0·6. If our purpose is to identify those cases in which there is a significant discrepancy between the intelligence quotient and a lower reading quotient comparison may be made by two methods, each of which must adopt some arbitrary convention as its border-line. These two methods we propose to call the "mental-age" method and the "regression" method.

The "mental-age" method involves taking some constant margin of difference, such as two years, and selecting cases in which the reading age is two years or more below the mental age. These cases are said to be retarded because the child's reading age falls so much below his mental age. In the sample of group testing which we are considering, since the children are 9 years of age, a difference of two years between mental age and reading age is represented by a quotient difference of 22 points. It should be noted in passing that this method has another disadvantage besides that to be discussed below, for a margin of 2 years is relative to age; other things being equal an increasing percentage of the population would be deemed retarded by two years or more with increasing age, and comparison of the incidence of retardation in different age groups would be invalid.

The "regression" method involves taking account of the actually observed relationship between the two tests—how well these two kinds of tasks go together in the population with which we are concerned, assuming that it is sufficiently homogeneous to justify the assertion of a relationship. From a knowledge of this relationship, expressed as a correlation coefficient, it is possible to calculate what score each child might be expected to have in the reading test from a knowledge of his score on the intelligence test. One could then compare the predicted score with the actual reading score and, using some conventional border-line, select those cases which showed significant discrepancy. The usual convention for expressing variability about a predicted score is the standard error of estimate; only 5% of cases might be expected to fall outside the limits of two standard errors above or below prediction; since we are concerned only with those cases in which the reading score is lower than the intelligence score the use of two standard errors as our conventional margin would mean adopting odds of 1 in 40, or higher, against the

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probability of such a discrepancy occurring. In most contexts above we have used the generic term "score"; it will be more convenient in what follows if we take examples which are measured in quotients.

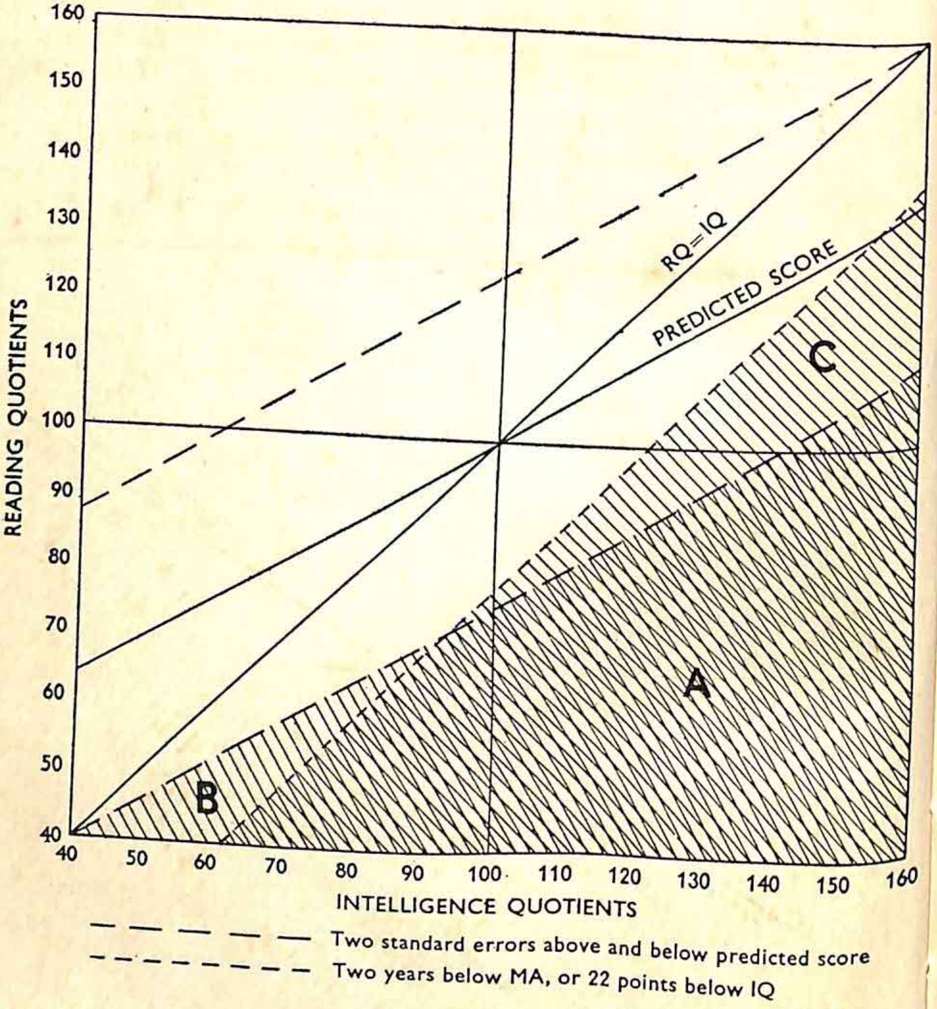


FIG. 1

(b) *An Example from Group Testing of Children Aged 9 Years*

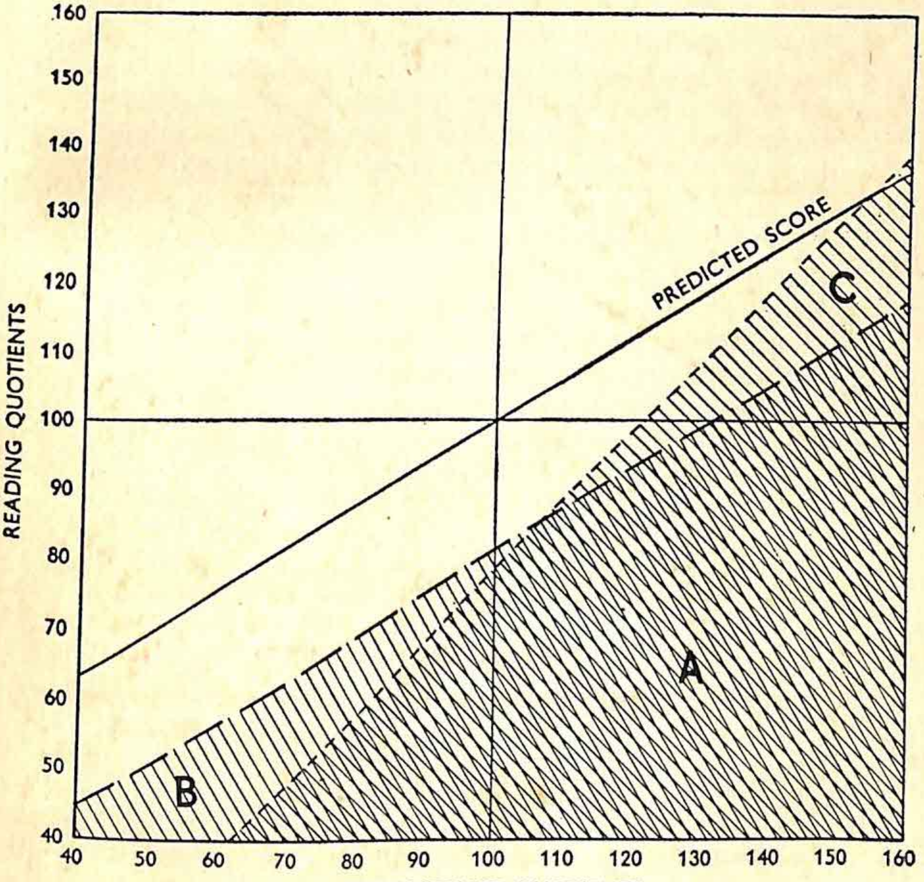
When the two methods are compared in the hypothetical case which we have described the following facts are immediately apparent (see Fig. 1):

i. The "mental-age" method will select many more cases than the "regression" method (using two standard errors); and these extra cases will have IQs of approximately 100 and over (Fig. 1, shaded area "C").

ii. The "mental-age" method will reject as not retarded a small number of cases in the IQ range of 40 to 95, who are significantly deviant on the "regression" method (see shaded area "B" in Fig. 1).

iii. The two methods will agree in the selection of a relatively small number of cases (shaded area "A").

Table 1 gives examples of cases falling in shaded areas "B" and "C".



— — — — — Approx. $1\frac{1}{2}$ standard errors below predicted score

- - - - - - - - - - - Two years below MA, or 22 points below IQ

FIG. 2

TABLE I

	Retardation in months	*Difference significant by more than 2 standard errors*			
		IQ =	MA	RQ =	RA
Difference greater than 24 months	47	126	11–4	82	7–5
	34	102	9–2	70	6–4
Difference less than 24 months	21	78	7–0	58	5–3

If the margin of what constitutes significant disparity on the "regression" method is adjusted so that it selects the same number of cases as the other method (in this example, adjustment to approximately 1½ standard errors) it then becomes possible to compare the two methods more directly. This is illustrated in Fig. 2. They will overlap in the selection of a certain proportion of cases (shaded area "A" in Fig. 2), but two contrasting groups appear in which they disagree: some high IQs from about 108 upwards will be selected by the "mental-age" method and not by the "regression" method (shaded area "C"), and some low IQs from about 108 downwards will be selected on the "regression" method but not on the difference between mental and reading ages (shaded area "B"). Table 2 gives some typical cases from these two groups.

TABLE II

	Retardation in months	*Difference significant by 1½ + standard errors*			
		IQ =	MA	RQ =	RA
Difference less than 24 months	21	78	7–0	58	5–3
	18	84	7–7	68	6–1
	22	98	8–10	78	7–0
		Difference not significant at 1½ standard errors			
Difference greater than 24 months	25	118	10–7	94	8–6
	30	130	11–8	102	9–2
	32	140	12–7	110	9–11

The "mental-age" method is used by many people. Teachers compare children's reading ages, or quotients, with similar measures from intelligence tests; and when such comparisons are made there is often an implicit assumption that a straightforward net difference between ages or between quotients is a legitimate and meaningful measure of achievement. Educational psychologists in a clinical capacity frequently do the same in making an appraisal of a child's response to educational opportunity as part of the diagnostic examination. The method is often used in the selection of children for remedial education by specialist services; of course, most remedial teachers would take other evidence into account besides differences of scores on group tests, but we are concerned here with how this particular class of evidence is interpreted. It is not the writer's purpose to discuss whether scores on intelligence tests should be taken into account in giving special help to failing children. He does confess to an obstinate conviction, based on clinical experience, that a useful distinction may be made between "backwardness" and "retardation", provided that proper criteria are employed to distinguish them. But it must be emphasised that nothing in this article has bearing on the question of whether bright children respond better to special help than dull children.

It is, however, obvious that the employment of a constant difference between mental age and, say, reading age leads to some very odd results. Among these would be the giving of remedial help to some children, above average in intelligence, who on any reasonable criterion of probability cannot be regarded as underfunctioning, and the withholding of such help from some children of average and below average intelligence who are showing significant retardation.

The two methods lead to very different conclusions, as may be illustrated by taking two extreme examples from our imaginary survey of children at age nine years.

Child A: IQ 80 = MA 7–2
RQ 64 = RA 5–9

Reading age lower than mental age by 1–5

Child B: IQ 140 = MA 12–7
RQ 116 = RA 10–1

Reading age lower than mental age by 2–6

On the "mental-age" method of selection, with a borderline of two years, one would place child B in the category of "significantly retarded" and take some action; but child A would be given no further attention. Yet, on the evidence of these two tests and the relationship which we have postulated between them, the discrepancy shown by child B would occur as frequently as 1 in 6 cases, approximately, whereas the discrepancy shown by child A would be expected to occur only in about 1 in 40 cases. The difference shown by child A on the two tests falls outside the limits of reasonable probability and would seem therefore to warrant further investigation; the difference shown by child B would occur so frequently that we should regard it as within the normal range of events.

(*c*) *The "Regression" Method*

The nature of the difficulty in employing the "mental-age" method is shown in Table III, which shows, for different correlations between tests, the size in months which differences must attain before they are significant to a given degree of probability. It is assumed in this table that the tests have means of 100 and standard deviations of 15; the margin of significance is taken as two standard errors; three cases are shown, all of mental age 10 years.

TABLE III

r	CA =	12–0	10–0	8–0
	IQ =	83	100	125
·3		25	35	44
·4		25	32	40
·5		25	31	36
·6		25	29	33
·7		24	25	28
·8		22	22	22

The full force of what is being said can best be appreciated from Table IV. The same assumptions are being made about the two

TABLE IV

Correlations between tests: IQ	·85	·80	·75	·70	·65	·60
60	10	10	10	9	9	8
70	11	12	12	12	12	12
80	13	14	15	15	16	16
90	14	16	17	18	19	20
100	16	18	20	21	23	24
110	17	20	22	24	26	28
120	19	22	25	27	30	32
130	20	24	27	30	33	36
140	22	26	30	33	37	40

tests as above. A range of correlations from ·6 to ·85 has been taken and the number of quotient points by which a reading quotient must fall below an intelligence quotient, for different values of the latter, has been calculated to meet the 1 in 40, or two standard errors, level of significance. The body of the table contains, therefore, the minimum values of IQ − RQ and all these values are equal in status. If the assumptions concerning mean and standard deviation hold, in the case of a group non-verbal intelligence test such as the "Sleight", which is unlikely to correlate at much above the +0·6 level with a test of reading, for example, then a child of IQ 80 and RQ 64 would show just as much deviation from normal expectation as a child of IQ 140 and RQ 100.

INFORMATION FROM TESTS

We are concerned here with the use of tests for a rather special purpose: the recognition of cases of marked educational retardation. Tests such as the Terman Merrill Revision of the Stanford-Binet and the Wechsler Intelligence Scale for Children are administered individually; those who use them usually have other information at their disposal in making assessments of a child; and such tests correlate highly with school learning. Group tests are another matter. There is little point in giving "verbal" group intelligence tests to children who are very poor in the actual skill of reading since one gains little more information than is available from a reading comprehension test. It seems unlikely that correlations between "non-verbal" tests and school attainments can ever be very high. Although other types of group test might be developed, a solution to the state of affairs which this article seeks to describe does not seem to lie in the hope of better, i.e. more predictive, group tests. And in any case it would be better to use the "regression" method in evaluating the difference between scores on two tests, even when their correlation is high.

The evaluation of the significance of a discrepancy between two scores is a practical proposition for the clinical psychologist; R. W. Payne and H. Gwynne Jones (2) have recently made a useful contribution to this clinical problem. What should be done by those who are concerned with numbers too large for the techniques they recommend?

In all the examples given above it was assumed that we were dealing with tests that have the same means and standard deviations. Uniformity in these respects is common to most of the intelligence tests which have been standardised in recent years. Attainment testing is not in the same class. Standard deviations vary greatly between different tests and at different ages; even the means of some widely used attainment tests no longer register contemporary average achievement. When the "mental age" method of comparison is used without recognition of the fact that the two tests concerned may have different basic units of measurement, a distortion may be superimposed on a method which is unsound. The following may serve as an extreme example of the resultant confusion. In a survey of intelligence and attainments recently carried out in a Birmingham junior school, tests were given to 96 second-year children (age group: 8 to 9 years). Comparison of mental ages from the Sleight Non-verbal Intelligence Test with attainment ages from Schonell's Graded Word Spelling Test showed that over 25% of the children were retarded by two years or more in spelling! When the "regression" method, which takes account of differing means and standard deviations, was applied to this data it was discovered that only in one case was the discrepancy between scores on the two tests significant at the 5% level and this was a case of "over-functioning"! Such results may be unusual but this example has been chosen to illustrate the possibility of grossly misleading conclusions from tests.

A 5% level of significance is not necessarily the right one to employ in all circumstances. This criterion, or approximately two standard errors, has been used in this article for the sake of simplicity. Some other convention might be employed and choice must depend upon experience within a particular range of problems. The main thesis of this article is unaffected by the criterion of significant disparity which is chosen.

In discussing the use of tests we have given examples in which the norms are expressed as "mental age" and "attainment age", or in "quotients" which are ratios derived by dividing such ages by chronological age. The logical and statistical arguments against the use of these units of measurement have been well stated elsewhere (3); these arguments, which arise frequently in the field of intelligence testing, apply equally to attainment testing (4). The writer believes that there are good reasons for abandoning the use of the unit "age" in the normative aspect of attainment testing. If we are told that a child has a mental age of 10 years and reading age of 8 years, we have learned nothing more than the fact that someone has been doing some testing. Is that difference large or small, common or rare? We cannot answer these questions without knowing how old the child is, what tests were used, how other children of his age perform on them, and what relationship between these tests can be observed in the population of which this child is a member. Yet so compelling is the reference to "age" that few of us can accept the facts and rid ourselves of the belief that we have been told something important, of the kind: "He has been courting for two years but hasn't proposed yet", or "She has been driving for two years but hasn't passed her test yet."

CONCLUSION

It is necessary to emphasise the very limited objectives of this article: to give a rationale to the concept of retardation and to examine some common practices in the use of scores derived from tests. This article has not been concerned with the nature of intelligence, the relationship between ability and school learning, or the importance of specific and general mental factors, although the background of thinking which is implicit here is most completely expressed by P. E. Vernon (5).

In the diagnosis of educational retardation one is not restricted to the evidence of tests. The teacher who is in daily contact with a child has information that one intelligence test cannot yield and which a whole morning's individual examination by a trained and experienced psychologist will not necessarily discover. The teacher, and the psychologist when he is involved, ought to make the fullest use of this information.

Some of the important information is to be had from formal tests. But where comparisons are to be made between intelligence tests and attainment tests, teachers, and others, should realise that false inferences can arise from the comparison of mental and attainment ages; and they should make allowance for the fact that as one progresses up the IQ scale there must be a greater difference between attainment score and intelligence score before it may be said that a child is retarded in his attainment.

NOTES AND REFERENCES

1. In fact, quotients derived in this way, from tests that have been standardised on age norms, are unlikely to have the same standard deviations, and moreover their standard deviations will vary with age.
2. Payne, R. W. and Jones, J. Gwynne, "Statistics for the Investigation of Individual Cases", *J. Clin. Psychol.*, XIII (1957), 115-121.
3. Pidgeon, D. A. and Yates, A., "The Use of Tests in the Classroom (5)", *Bull. No. 7, Nat. Found. Educ. Res.*, VII (1956), 6-11.

4. The exception seems to be those situations in which one wishes to know, for diagnostic purposes, the point which a child has reached in some process of learning which can be broken down to a sequence of irreversible steps; if there are discriminable stages in the acquisition of some complex skills it might be useful to scale these stages in terms of the ages at which they are usually reached. But this function of tests needs to be distinguished from the normative one in which one wishes to assess a child's performance in terms of other children of his age.
5. Vernon, P. E., "The Psychology of Intelligence and G", *Bull. Brit. Psychol. Soc.*, XXVI (1955), 1-14.

NUMBER READINESS

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1. THE TEACHING OF NUMBER

THE many personal and social adjustments demanded of the young child in the earliest days of his school life are of sufficient complexity to make considerable demands on his physical, mental and emotional resources. The period of orientation to the new environment will vary according to the individual and provides an opportunity to assess the extent to which the child is ready to face the more formal demands which are to be made upon him. The reading process has enough contributory factors, many of them readily recognisable, to prompt the teacher to introduce the early stages of the reading programme with care and discrimination. Premature demands are often conspicuously unsuccessful and, if pressed, are likely to result in overt manifestations of emotional stress. It follows that few teachers, by virtue of such experiences, are unaware of the concept of "reading readiness".

Relatively few five-year-olds, however, fail to convince that number work, including the carrying out of simple computational procedures, lies within their capacity. The supportive evidence includes the child's ability to achieve one-to-one correspondence between the "number song" and a cardinal group, along with a capacity to associate a conventional symbol with a corresponding domino or other configuration. As the decimal base of our system of notation providentially coincides with the normal complement of finger and thumbs, an ever-present concrete aid is available for those not responding to more abstract forms of presentation. Prior to the last war, such an approach to arithmetic was accepted without question, and in accordance with Association theory, the "frequency, recency and intensity" of the inevitable drills and practices was considered to be in relation to the measure of success to be expected. Functional arithmetic, frequently of the tap-filling-tank variety, was a by-product of a programme devoted almost exclusively to computation. In 1930, the Preface to the *Yearbook of the N.S.S.E.* (1) stated of arithmetic teaching: "The main psychological basis is a Behaviouristic one. This is in contrast to the more recent Gestalt Psychology which, though promising, is not yet ready to function as a basis of elementary number." Flavell (2), in evaluating the traditional approach, condemns the great emphasis on computation, the lack of emphasis on understanding, and the standardisation of methods leading to "blind manipulation"; he appeals for an exhaustive review of the aims and purposes of arithmetic. This paper sets out to examine the problems implicit in a situation in which a logical and ordered numerical system is to be presented to children whose thinking is generally prerational, uncoordinated and based, at best, on intuitive guesswork.

In view of the prevalent notions on methods of teaching arithmetic, it is not surprising that early research into "arithmetical readiness" tended to take the form of objective assessments of the extent to which children of varying mental and chronological ages responded to practices and drills in particular arithmetical topics. Outstanding amongst such papers are those of "The Committee of Seven" (3), Morphett and Washburne (4), Buckingham and McLatchy (5), Curr (6) and Brownell (7). Such an approach was a logical means of regulating and postponing what were considered to be the appropriate drills for the particular topic. A typical conclusion is quoted from Washburne (3): ". . . children should not begin a study of easy subtraction facts until they have a score of 84-95% in the addition facts." Curr, in seeking to discover whether postponement improved or diminished efficiency of learning, found that it made little difference, that it may either increase or diminish it, and would vary from class to class. He concludes however, ". . . it still seems probable that there may exist a mental age below which a topic cannot be efficiently learnt."

The present trend is to consider the problems of number readiness in the light of contemporary notions as to the nature of number and its relation to quantitative thinking. Number is concerned with relationships within and between quantities, where "quantities" is understood to include not only cardinal groups, but also units of capacity, measure, duration, weight, speed, temperature, etc. Arithmetic is the medium through which the thought processes involving such relationships are resolved. Arithmetical notions are expressed in terms of conventional sounds ("one", "two", etc.) and Hindu-Arabic symbols, meaningless in themselves, but which we may regard, with Wheat (8) as ". . . the vehicle for carrying our number thinking along." Piaget's support for a relational approach to number is inherent in his hypothesis that its development goes hand in hand with the development of logic and that it can be defined as "... the synthesis of class and asymmetrical relation" (9). Here the idea of group relationships is fused with an understanding of the hierarchical nature of inclusive classes (e.g. food > fruit > apple > pippin) to make a single operational system. Dewey (10), in more familiar terms, sees number as "... the putting of units (or parts) in a certain ordered relation, one to another." He continues, "Number cannot be taught by the mere presentation of things, but only by such presentation as will stimulate and aid the mental movement of discriminating, abstracting and grouping, which leads to definite number ideas." A remarkable statement for its time (1895) and one which serves to remind that the basis of number is the formulation of ideas.

Such an approach, coupled with present day notions as to the functional value of number, reveals two major inadequacies in the "age-topic placement" methods of ascertaining readiness. Primarily, the notion of an isolated topic as part of a fixed progression is contrary to a way of thinking which regards the basic processes (the "four rules") as complementary and interrelated. For example, the child's ability to resolve $4+5=9$ cannot be regarded merely as a necessary preliminary to tackling $14+15$ or $40+50$. Rather shall we expect the child, not only to comprehend that $4+5=9$, but also that $5+4=9$, $9-5=4$ and $9-4=5$. A second criticism must be that, if we use an "age-topic placement" method of assessing number readiness, the criterion for mastery is computational accuracy and the all-important question of transfer and generalisation is either ignored or, by implication, dismissed as not being susceptible to statistical disciplines. To return to the previous example, we shall not only wish the child to understand the total additive composition of 9, including 5 and 4, but given a classroom or real-life situation involving 9 objects, we shall expect him, through understanding, to select the arithmetical process or processes required in its solution.

Where enjoyment, retention, understanding and the child's ability to generalise are considered to be the criteria of success in teaching number, the "structural" approach is receiving increasing recognition. By this method, concept formation and appreciation of numerical relationships are fostered with semi-concrete material in the form of wooden rods of proportionate length. The use of such material in the teaching of arithmetic dates back to the time of Pestalozzi, and a like principle is apparent in the Tillich Number Kit (18th century), the Beldanes System and the Montessori "Stair". More recently the coloured rods of Cuisenaire, the Catherine Stern "Structural" material and the Lowenfeld Poleidoblocks, all variations on a similar theme, have become available. During the course of fairly extensive use of such material in a school for educationally sub-normal children however, it has become apparent that younger and more backward children tend to use the rods merely as an aid to computation, in as rigid and mechanical a manner as the counting of the traditional cowrie shells. Now arithmetical apparatus, according to the Report of the Mathematical Association, *The Teaching of Mathematics in Primary Schools* (11), should fulfil the following functions:

- (*a*) Promote realistic situations in which children can discover facts.
- (*b*) Provide the necessary tools to investigate and measure.
- (*c*) Make an idea clear.
- (*d*) Foster memorising and skill.

Thus, though all the children had been taught with understanding, using simple material of approved mathematical and psychological worth, the rigidity and immobility of the number thinking of some of them was such that the material was not fulfilling the above functions. In the light of the failure of these children, whose retention is poor and who are found to be unable to generalise, there would appear to be a need for:

- (*a*) A test of number readiness, to analyse the child's quantitative thinking processes, to predict his readiness to understand and generalise and finally to give some indication of what the child is ready for.
- (*b*) For children who, by such criteria, are not ready for formal number, a practical classroom programme that will stimulate and foster number thinking at a pre-symbolic level.

The work of Piaget (9) is generally considered to be fundamental to the solution of both problems, for he is primarily interested in the genesis of mental operations and the analysis of the principles which determine the extent of the child's appreciation of quantitative relationships (12). The criticism levelled at Piaget's lack of statistical precision, his disregard of accepted psychometrical procedures and the unstandardised nature of his "free conversation" technique are irrelevant to the present problems, for the prime consideration is the nature and order of the developmental process rather than the obtaining of correlations.

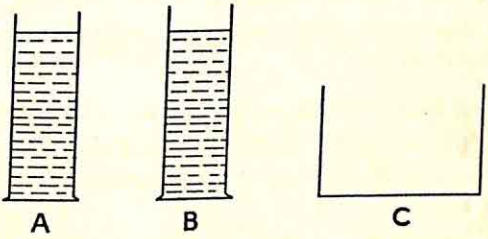
A preliminary stage in the composition of both a test of number readiness and a classroom readiness programme was the verification of Piaget's main hypotheses by the construction of a Test Battery composed of representative experiments from his work. This completed, a second stage was to attempt to review everyday classroom problems in the light of such theories by constructing a simple arithmetic attainment test to relate computational ability to an apparent level of concept development. A Pilot Experiment was carried out at St. Francis Residential School in which 24 educationally subnormal children were tested with a wide range of tests; and then the Battery, in its final form, together with the Attainment Test, was given to 20 "normal" infant children whose ages ranged from four-and-a-half to six years. The final selection of tests which comprised the Test Battery was as follows:

2. The Test Battery

Test 1: *Conservation of Continuous Quantities*

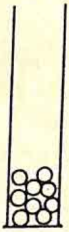
Materials

3 cylindrical glass jars, proportioned as shown, with jars A and B containing an equal amount of coloured liquid.



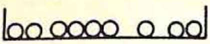
Procedure. By comparing levels, the child agrees that jars A and B contain similar amounts of liquid. The liquid from jar B is transferred to jar C and the child is asked whether the quantity of liquid in A and C is still the same or whether one or the other contains more.

Test 2: *Conservation of Discontinuous Quantities*



Materials

1 tall cylindrical glass container.
1 small flat tray.
40 marbles.



Procedure. The child places marbles, one by one, into one container at the same time as the tester places them into the other container. If, on questioning, the child denies that there is the same number of marbles in each container, the experiment is repeated with child and tester counting together. The child is then again questioned as to the equivalence of the two sets of marbles.

Test 3: *Cardination* (*Provoked Correspondence*)

Materials

6 "Garages" (Child's wooden toy bricks).
10 "Cars" (Smaller blocks of wood, appropriately shaped).

Procedure. The "garages" are placed in line about 2″ apart and the row of "cars" placed at some distance from the testing table. The child is asked to bring just enough "cars" so that every garage has a "car". The manner in which correspondence is achieved is noted. The child then agrees that there is the same number of "cars" as "garages".

During the course of a simple story the "cars" are now spread as follows:

G G G G G G
C C C C C C

The child is now questioned as to the constancy of the two sets. Finally, after re-pairing the "cars" and "garages", a story is told in which the sets are placed as follows, one "car" being removed by the child:

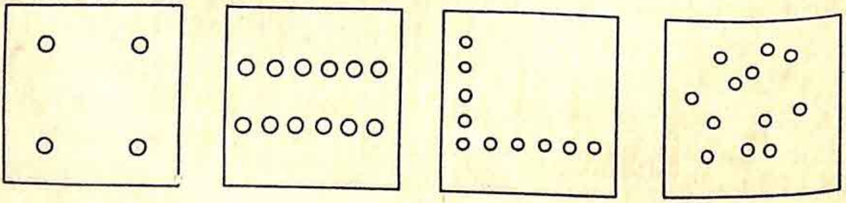
G G G G G G
C C C C C

Then follows final questioning as to the constancy of the sets.

Test 4: *Cardination* (*Unprovoked Correspondence*)

Materials

A quantity of loose counters.
4 cards with counters arranged as follows:

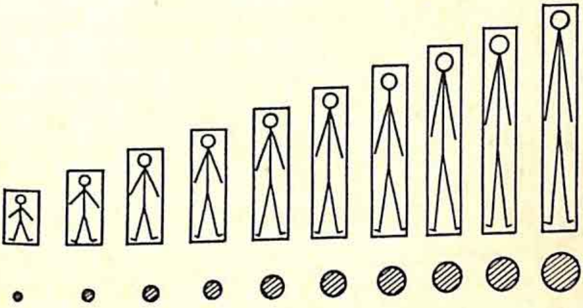


Procedure. During the course of a short story, the cards are presented separately to the child who is asked to take from the pile the same number of counters appearing on the card. The manner of achieving correspondence (counting, pattern copying, etc.) is carefully noted.

Test 5: *Ordination*

Materials

10 graduated dolls forming a simple series.
10 graduated footballs forming a simple series.

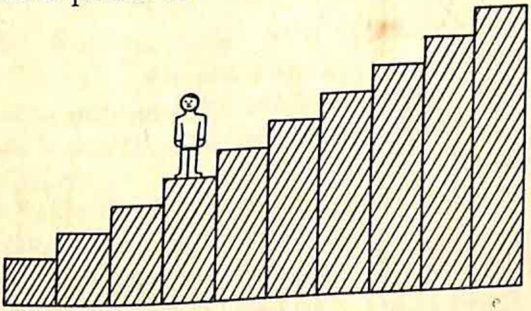


Procedure. The child is asked to form a "stair" with the dolls (simple seriation) and then to place the footballs so that each ball is at the foot of the corresponding doll (as above). After the correspondence has been pointed out to the child the dolls are spread out in line, their order is reversed, and finally they are placed in non-serial order; in each case the child is asked to point to the ball corresponding to selected dolls in the series.

Test 6: *Synthesis of Cardination and Ordination (i)*

Materials

10 wooden rods to form a simple series.
1 small plastic doll.



Procedure. The child is told to form a simple series with the rods. The doll is then moved "upstairs", touching the top of each rod as it ascends. The series is then disarranged, the doll is placed on top of one of the rods selected at random, and the child is asked how many steps the doll has had to touch to reach the one selected. The experiment may be continued with the selection of a further rod; the child being asked how many more steps the doll must touch before it reaches the top of the "stair".

Test 7: Synthesis of Cardination and Ordination (ii)

Materials

8 flat wooden laths, measuring from 1″ to 8″ respectively.

Procedure. The child is asked to make a simple series with the laths and, having done so, to count them. He is then asked how many pieces of wood, the length of the first unit, could be obtained by cutting up other laths in the series. Note is made of the manner in which he arrives at his answer.

Throughout the examination, the child is asked to give reasons for his responses and actions, and these are noted on a test form. At the conclusion of the test, by reference to the original text, the child is assessed as "pre-operational", "intuitive" or "operational" on each test item (14).

3. THE ARITHMETIC ATTAINMENT TEST

The construction of this test was based on the supposition that most children have been taught by methods based on enumeration, and thus it represents an analysis of the counting operation, from simple enumeration of objects at a sensori-motor level, to the first stages of relational counting.

Section (1): Enumeration

(*a*) Simple enumeration of a line of 20 counters.
(*b*) How many counters have I here? (Show 3, 6, 8 and 12 counters).
(*c*) Pass me—counters from the pile. (4, 7, 9 and 13).
(*d*) Evaluation of dissimilar groups. ("Where are there more counters?")

3 and 4
5 and 4
8 and 7
11 and 12

Section (ii): *Counting-On*

The child counted a quantity of beads into a bag. A further amount of beads was then given to the child who was asked to give the total without referring to those in the bag.

2 (hidden) + 3
4 (hidden) + 2
5 (hidden) + 4
6 (hidden) + 5

Section (iii): *Reversibility*

The child was asked to do small groups of sums in complementary addition and subtraction, e.g.

$2+7=$
$9-2=$
$7+2=$
$9-7=$

Note was made as to whether the child approached each item mechanistically and without reference to the other items in the group, or whether there was evidence of appreciation of the complementary nature of the operation.

4. THE TEST BATTERY IN USE

In assessing the effectiveness of the Test Battery as a measure of number readiness it will be apparent that, with so small a sample, conclusions can only be regarded as tentative and subject to modification. Further experience with the Test material however, subsequent to the original inquiry, has tended to confirm the earlier findings. In comparing the results of the Attainment Test with the final assessments on the Test Battery, it is apparent that some children are able to perform computations, with some degree of accuracy, prior to any real appreciation of the nature of number relationships. Such children, on further investigation, are unable to make any but the simplest generalisations, and it must remain a matter of conjecture as to what proportion subsequently become unhappy and insecure in relation to number activities. Perhaps it is with these children in mind that Flavell (13), quoting from Christopher Fry, refers to going ". . . still deeper into the calculating twilight". In general, however, from the evidence of this inquiry it would appear that there exists a high positive correlation between the child's ability to appreciate the constancy of both continuous and discontinuous quantities, and his ability to perceive the complementary nature of the addition and subtraction processes. This "reversible" reasoning is an essential factor in problem solving (16).

A proportion of the children appeared to show marked aptitudes on certain sections of the Test Battery. Four of the "normal" children, failing in Test 1 (Conservation of Continuous Quantities), were able in Test 2 (Conservation of Discontinuous Quantities) to appreciate the constancy of the two sets of marbles by means of what Dewey (10) might have termed "relational counting". Each also had "operational" assessments on other tests involving cardinal groups (Tests 3 and 4) yet were "pre-operational" with the rods and balls in Test 5. On the other hand, other children were successful with the ordinal material but appeared to be unable to appreciate the significance of the cardinal groupings. Such information is of some prognostic value in selecting appropriate teaching methods for the individual, and answers, at least in part, the question "Readiness for what?".

A familiar problem to those engaged in remedial work in arithmetic, particularly with older children, is the determination of the extent to which a child's disability stems from affective, as distinct from cognitive, factors. As the root of the emotional problem is frequently the premature use and misunderstanding of conventional symbols, their use will invalidate any diagnosis in which they play a part. As an adjunct to a comprehensive longitudinal study, the Test Battery has proved itself capable of determining the level of a child's quantitative thinking, as concept formation is tested without resort to figures, signs or formulae. One boy, Stanley, CA $15\frac{1}{4}$ years, IQ 68, had a Reading Age of about 9 years with a commensurate level of comprehension, but was unable to achieve anything in number work apart from simple enumeration. When presented with the simplest of "sums" he would stammer, perspire and show obvious signs of emotional stress. That his difficulties were other than intellectual was confirmed when he completed all items in the Test Battery with ease and understanding. This knowledge was instrumental in deciding remedial measures.

A number of alternative responses are expected in individual test items and the nature of the succeeding question is determined by the examiner's spot assessment of the child's maturational level as evinced by his response. Reliance to such an extent on the examiner's knowledge and interpretative powers must be regarded as a disadvantage if some such test of readiness is to be more widely used. Miss Churchill (17), after wide testing experience with similar material, raises the same point. Despite this, however, it can be fairly claimed that some such Test Battery has potentialities as a tool for the assessment of the readiness of the individual child to proceed with understanding to more formal work, and may, in addition, give some practical guidance as to what type of approach is likely to be most successful. In individual remedial cases, with a competent tester, the Tests may form an important and integral part of the diagnostic procedure.

To the infant teacher, however, who in addition to her concern for the academic development of up to 50 children must also minister to their social, physical and personal needs, such a test procedure can be of but academic interest. Simple adaptations of sections of the test may be possible in the case of an individual problem, but a practical group application, in view of the age of the children and the complexity of the procedure, would appear to be out of the question. For the present, the part of the teacher is to bear in mind the relational nature of the number system and the developmental nature of the young child's comprehension of these relationships. Her task is not so much to teach, in the sense of disseminating information, as to provide ways and means of helping the child to think about quantities in accordance with his developing notions. Sympathy, encouragement and practical experiences are the main needs of the child who is obviously struggling, and who all too often has been subject to undue pressure in the form of multi-item diagnostic tests and remedial devices to improve his "figure juggling".

5. CAN NUMBER CONCEPTS BE TAUGHT?

The answer to such a question can only be decided by providing practical experiences which harmonise with current developmental theory. There is, for example, little in Piaget's original work to suggest that manipulation of the environment will in any way affect concept development. In view of the strong emphasis frequently placed on counting in the early stages of number teaching, it is of note that Piaget states, without ambiguity, that counting has no effect on the mechanisms of numerical thought (18). In his book *The Psychology of Intelligence* there is a similar denial of either social or environmental influence, prior to the stage of formal operations (19). Some modification of this view is apparent in Inhelder's statement in 1953 that "the age at which structures appear is relative to the environment, which can either provoke or impede their appearance." She continues "Rational, rather than magical representations have been shown to develop more quickly in an atmosphere of free interchange and discussion" (20). More recently Churchill (17), reporting on the use of Piaget tests, writes, "Evidence of this inquiry suggests that educational factors can influence the rate of progress and the form that it takes." Following a further testing programme, Lunzer (21) suggests a programme whereby ". . . the teacher is deliberately educating children rather than waiting for development to take its natural course." Such conclusions are in harmony with contemporary notions of intelligence as a dynamic concept, subject to environmental influences of all kinds. If, as Piaget suggests, the development of number concepts is synchronous with, if not an integral part of, cognitive development, then we are entitled to expect to be able to exert a positive and lasting influence on the young child's number thinking. What then should be the nature of such influence?

Whilst there is ample evidence in infant schools of the enthusiasm and ingenuity of teachers in devising practical number apparatus, the *Report* of the Mathematical Association (11) sounds a cautionary note. Though strongly emphasising a relational approach to number, the *Report* advises the teacher ". . . to provide the materials of experience which are in general those of ordinary living and of common childlike occupation, rather than specialised objects designed to make clear particular properties and stages." Application of these principles may take the form of a non-directive Froebelian approach whereby the child is expected to internalise and co-ordinate quantitative relationships through a wide range of experiences and activities with only incidental help from the teacher. Alternatively, there may be devised a deliberate and systematic programme wherein the children discuss, express ideas, handle materials, indicate choices and make decisions in a conscious attempt to understand the quantitative relationships and properties of the "natural" material around them. In either case there is the basic assumption that the combination and interplay of maturational and experiential factors will hasten, or at least give depth to, concept formation.

Mention has been made of a number of young and backward children who were failing in number work. Despite adequate practical experiences in a stimulating and permissive environment they were responding wholly at a perceptual, pre-rational level, and their counting was little used apart from simple enumeration of objects and providing metronomic sounds in familiar nursery number jingles. In simple exercises using counters, water and sand they were unable to assume constancy if one of two quantities was altered or restructured. In briefly outlining a programme contrived for such children, it should be stressed that at its present stage of development it should be regarded as experimental, being subject to constant revision as activities are devised, modified or rejected.

6. A Classroom Number Readiness Programme

Contrary to the advice of the *Report* of the Mathematical Association, there is implied in the readiness programme now to be described a fundamental assumption that, in some cases, basic principles of quantitative relationships are best demonstrated in the simplest possible situations. These involved prepared activities using the most elemental materials such as wet and dry sand, water, unit blocks, wooden rods, clay and plasticine. The child who, in a generalised programme, has been unable to isolate a basic principle from a large number of widely differing and, to him, confusing situations, may by this means have it demonstrated without extraneous and distracting factors. Once the principle has been grasped by the child, the teacher's task is to ensure its application in as wide and varied a range of situations as possible. When difficulty is encountered in achieving this high degree of transfer, return is made to the elemental materials for further reinforcement. This cannot be regarded as a novel or original approach, for if its principles are correctly interpreted, the Stern and Cuisenaire material is used in a like manner at later stages of the number programme.

In the early stages of the programme, the child is helped to acquire a working vocabulary of comparative terms of size, amount, length, distance, location, time, etc. Conventional units of measure such as "inch" and "pint" are not included as all measuring is carried out in terms of comparative lengths. A typical activity is one in which the child is asked which he considers to be the greater of two piles of sand. After making a preliminary estimate, some form of confirmatory activity follows such as filling "unit" cups, weighing with "unit" weights or making sand pies of identical size with a small mould. The respective lines of cups, pies or weights corresponding to the original quantities are placed side by side in pairs so that a comparison can be made and the original estimate checked. Here the child is being assisted to appreciate constancy by resolving three interrelated factors (the length, breadth and height of the original piles of sand) in terms of a single comparative measure. Piaget describes such an operation as "logically multiplying" the relationships involved. Again, the form of the activity is such that no new principle is involved as it is sound mathematical practice at any level to test the child's understanding of a problem by demanding a preliminary conjecture as to the likely answer. Such a procedure is well-nigh impossible when teaching and learning is by formula or habituation.

In an exercise in ordinal correspondence, the teacher has a series of 8 wooden blocks, each 2 inches square in section, varying in length from 7 to 14 inches. These are placed upright in order of length. Each child is then asked to cut, from a long strip of manilla card, a series of strips corresponding to those of the teacher, forming his own smaller "stair" which he can lay flat and manipulate on his own desk. The children place their strips in order of length and are then asked to indicate various strips corresponding to those selected at random from the teacher's "stair". The activity continues with the teacher lengthening, reversing or disarranging his "stair" and the children again pointing out their own strips corresponding to those selected by the teacher. A further progression may be the introduction of a third series (plasticine balls) which are seriated and made to correspond to one or both of the original series. The activity continues by reference to the relative heights of trees, buildings, etc.; or by groups of children standing in line and "seriating" themselves. Given regular and progressive practice of this nature, children are found to be able to achieve ordinal correspondence, regardless of the juxtaposition of the items in the series. Children are not told to "count along" to achieve this correspondence and in the early stages very few are found to do so, but later they discover for themselves that counting is essential to the solution of the more difficult tasks. Such counting, used spontaneously and as a means of comparison, may be considered to be truly relational.

It will be apparent that the child's kinaesthetic and motor activity in these experiences is incidental to the thought processes through which he is being guided, and it has been noted on occasion that the child watching others carry out an activity will explain to the adult observer the purpose of the exercise, whilst the "doers", when questioned, merely describe their actions. On one such occasion a performer volunteered the information that he was "making a lot of pies with the egg-cup and the sand", whilst the child observing remarked, "They are trying to find out who has more." In such a situation the latter child might well be considered to be the more active of the two, for the performer has lost sight of the original aim by his involvement in the means. This is not, of course, to deny the place or value of spontaneous play and natural motor activity in the young child's physical and personal development, but to suggest that for a short period he be asked to discipline his thoughts and actions to specific ends. That this can be acceptable to the children is apparent from their interest and absorption during the regular half-hour sessions, and the amount of progress made. Those children who have been promoted from the "readiness" group, having been assessed by the standards achieved during their activities as being ready for more formal work, have all been reported to make good progress using structural methods.

Whilst "readiness" has been considered solely in terms of developing concepts allied to experiences designed to promote understanding of both purpose and method, consideration must be given to further capacities and characteristics, innate and acquired, which are fundamental to an all-embracing concept of number readiness. Such factors include pre-school experiences, emotional and personal attitudes, social adaptability, specific mental factors such as retention, sensori-motor abilities essential for counting and recording, and auditory and visual perception. Individual differences in such varied aspects, not always self evident, are likely to ensure that no two growth patterns are identical. Such is the nature of the challenge to the infant teacher, the resolution of which, even in part, must depend on a far wider awareness than prevails at present that such a problem even exists.

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THE UNIVERSITY AND THE SIXTH FORM IN THE GRAMMAR SCHOOL

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IT is self-evident that nowadays universities in England and Wales must be deeply concerned with the work of the sixth forms in the grammar schools supported by public funds. The great majority of those now entering universities come from these schools, and the kind of training they have received during their two or three years spent in the sixth form has an immediate bearing on what can be expected of them when they arrive at the university.

This situation is of quite recent growth. Grammar schools, as we know them, are the creation of the so-called Balfour Act of 1902, and it is perhaps worth noting that their appearance more or less coincided with the granting of charters to the five great civic universities of Birmingham, Leeds, Liverpool, Manchester and Sheffield. A few salient facts will serve to show the development of the grammar schools over the past fifty years, and to indicate how, from very small beginnings, they have now become the chief suppliers of students to universities in England and Wales.

In 1908 there were just over 100,000 pupils in grammar schools on the Grant List. Now that number has risen to about 800,000. Today there are as many boys and girls in sixth forms alone as there were in every form of all the grammar schools helped from public funds fifty years ago (1). At that time the English universities drew the great bulk of the 10,000 or so students they contained from schools outside the state system; that is from what we now call the independent schools. Even in 1930, when their student numbers had risen to around 30,000, these same universities only drew 36% of their entry from grammar schools on the Grant List. In 1956 the total number of students in the universities of England and Wales was just over 70,000, and three-quarters of those who matriculated in that year came from grammar schools in the state system. Moreover of these only about 20% went to the two ancient universities of Oxford and Cambridge, the bulk was spread among the modern universities (2).

Of course the sixth form in the grammar school is not, and never has been, simply an avenue to the university. Precise information on this subject is hard to come by, while the situation varies from area to area, and often from school to school. However, in September 1957 the Northern Universities Joint Matriculation Board published some interesting facts about the careers chosen by those who had taken its examination for the General Certificate of Education in the summer of 1956 (3). Of the candidates from maintained grammar schools and from direct grant schools who offered subjects at the Advanced Level, roughly 60% of the boys found their way to a university, but only about 30% of the girls (4).

These figures only cover just under one third of all the candidates who took the General Certificate at Advanced Level in the summer of 1956, and the Northern Board's entry is drawn almost entirely from schools in the North and the Midlands. Nevertheless, it would probably be reasonable to assume that at present the universities only claim rather more than half of those who pass through the sixth forms of grammar schools. They will take more of the boys, but fewer of the girls. Those sixth form boys from grammar schools who do not enter universities go straight into business, to industry, to the professions or to teacher training colleges. Indeed the Northern Board's survey showed that no less than 56% of all the sixth form girls who took Advanced Level subjects in the Board's G.C.E. examination in the summer of 1956 were subsequently admitted to training colleges (5).

This, then, is one side of the problem of the present relationship between the universities and the sixth forms of the grammar schools. The universities now depend very heavily on the grammar schools for students. The grammar school sixth forms are larger than ever before, but a sizeable fraction of those who pass through them will not go to universities. But there are even more far-reaching implications of this situation which need to be taken into account.

It does not follow that a sixth form course designed to prepare candidates for university entry will necessarily meet the needs of those going straight to the professions, to business, to industry or to the training colleges. Neither can it be assumed that the type of systematic, specialist preparation considered necessary by universities for direct entry to a degree course is, from the teacher's point of view, educationally the best kind of sixth form training. This last point is of great importance. For practical purposes sixth form work in the grammar schools is now shaped by the demands of the Advanced Level syllabuses for the G.C.E. All universities in England and Wales, except Oxford and Cambridge, now state their entrance requirements in terms of the G.C.E. Generally speaking the Minimum Entrance Requirement, which embodies the test of non-specialist attainment, can be satisfied by passes in two subjects at the Advanced Level, together with passes in the prescribed spread of Ordinary Level subjects. These latter, whatever may have been the intention when the General Certificate of Education was instituted, are now usually taken before entry to the sixth form. The pupil who has to take Ordinary Level subjects in the sixth form will usually find himself at a disadvantage in his Advanced Level work compared with those of his fellows not similarly burdened.

However, as is well known, to clear the Minimum Entrance Requirement is to have done no more than surmount the first obstacle in the way of university entry. The Faculty Requirement still remains and, in most universities, this demands passes in three subjects at the Advanced Level. But few will gain a university place on a row of bare passes at the Advanced Level. There is competition among the qualified, and Advanced Level marks of 60 or even 70 are now commonly necessary for salvation.

Many of those best able to judge would agree that, in general, the present Advanced Level syllabuses are too heavy. To some extent, particularly, but not exclusively, in the sciences, this reflects the rapid growth of knowledge. Subjects, even at the pre-university stage, change their shape, new knowledge must be incorporated, and even if this is accompanied by a pruning of what is already there, as is not always the case, the usual result is to make the syllabus demand heavier than it was before. It is commonly supposed that the universities, through their Examining Bodies which administer the General Certificate examination, are directly responsible for imposing the Advanced Level syllabuses in their present form on the schools. Were this really so the matter might easily be remedied. Unfortunately the actual situation is much more complicated and much less tractable than this simplified version of it suggests. The present Advanced Level syllabuses are only new in name. They are the direct descendents of the old Higher School Certificate Principal syllabuses. As such they have attached to them a powerful tradition both of teaching and examining reaching back to 1918 when the Higher School Certificate examination was instituted (6). This is something which may be gradually modified, but it cannot be suddenly and radically altered. Of course Advanced Level syllabuses are constantly reviewed, but in many Examining Bodies the committees charged with this duty include a substantial number of sixth form teachers, as well as university specialists in the subjects concerned. Naturally they will view the matter from the standpoint of the specialist rightly anxious to provide the best and most comprehensive training in the subject. They are hardly likely to propose reductions in syllabus requirements, and their recommendations must necessarily carry great weight both with the Examining Bodies and with the various teachers' organisations, who are frequently consulted. Finally it is important not to neglect the influence of the Secondary School Examinations Council in this connection. This body, first established in 1918 as a ministerial advisory panel, has since 1951 exercised, through the advice it tenders to the Minister of Education, a wide measure of control over the working of the examination for the General Certificate of Education, and particularly over the syllabuses proposed by the various Examining Bodies, which need its approval. Yet, in all this, there seems to be no effective provision for reviewing the working of the examination as a whole, as distinct from the periodic scrutiny of individual syllabuses.

The universities, apart from those of their members who serve on the various Examining Bodies, have, of late years, been too little interested in the Advanced Level papers and the syllabuses on which they are based, even from the narrow standpoint of their suitability as a preparation for entry on degree courses. University people tend to grumble about the inadequacy of the Advanced Level course, and to blame the schools, which is easy and not very profitable, for encouraging unnecessary sixth form specialisation. Many in the universities find it extraordinarily hard to realise that, given the existing Advanced Level syllabuses, the manner in which Faculty Requirements are shaped and operated is one of the principal causes of that sixth form narrowness and premature specialisation which they deplore.

The truth is that a boy or girl seeking a university place must spend practically the whole of the two-year sixth form course in concentrated work on the three Advanced Level subjects which the Faculty Requirement demands. There is no time for that general education by which universities set such store. It is true that considerable and praise-worthy efforts are made by many sixth form teachers to maintain and develop their pupils' interests in things outside the scope of their specialist work. Yet this must be for many a thankless task, since no examination test has to be satisfied, and what is done is not of obvious and immediate practical usefulness in the mundane business of securing a university place. Moreover those sixth form pupils not intending to seek entry to a university must, in many grammar schools, of necessity conform their work to the pattern prescribed for those whose aim is a university course. This is a matter of hard necessity. Teaching resources are limited, and a variety of sixth form options cannot be provided. Indeed in some sixth forms the exigencies of the time-table are such that only a restricted choice can be provided among the normal Advanced Level subjects. Not infrequently university interviewing boards are told by candidates seeking admission that in their schools it was not possible to take all the Advanced Level subjects they would have liked to choose.

It remains to inquire how the situation just described can be improved, for it is clear that improvement is desirable. There is surely little to be said in favour of a system which, in practice, curtails the broad humane training traditionally given by the grammar school at 16 or, for some pupils, even at 15; and which subjects those entering sixth forms, whatever their ultimate choice of career, to a uniform, highly specialised and heavily factual course of study for a minimum of two years. For those who spend three, and sometimes even four, years in a sixth form the mischief is even worse, for they will be called upon to repeat, at least once, the course and examination they have already taken. Few sixth form teachers, surely, can regard this situation with complacency. After all, the sixth form now provides them with an opportunity of moulding the intellectual development of their ablest pupils at a time when, for many of them, that development is quick and exciting. Nor is this a condition of things which universities ought to think tolerable. Subjects taken at the Ordinary Level two or three years before university entry, and then promptly abandoned by the pupils concerned, are of scant usefulness as the basis of the general, as distinct from the specialist, education of the future student. Also there is reason to think that an Advanced Level syllabus, less heavy and better suited as a preparation for university entry, could be devised in many subjects. Clearly a single syllabus, say in physics, can hardly be an effective preparation for the candidate who will take a university honours course in physics, for the candidate who intends to enter one or other of the university engineering schools, and for the candidate who may well find his way into an honours course in mathematics or in chemistry. At the other extreme it is impossible to contemplate a state of affairs in which sixth forms attempt to offer too wide a choice of courses. This would simply reproduce the chaotic situation which threatened to prevail before the Higher School Certificate examination was introduced in 1918. At that time it was said that there were no less than 100 different examinations of universities and professional bodies for which grammar school pupils might wish to be prepared (7).

There would probably be little disagreement between experienced sixth form teachers and the universities about the principles on which a satisfactory sixth form course might be constructed. First, it ought normally to be envisaged as extending over two years. Of course it is impossible and undesirable to hold back the bright boy or girl at the Ordinary Level stage. The malign effects of trying to do this were surely sufficiently demonstrated when an age restriction at this point was imposed in the earlier years of the General Certificate examination. All the same it may well be that many who would benefit from a slower ascent through the school, are at present pushed forward too quickly through the Ordinary Level examination to the sixth form. Again, although, at first sight, this may seem paradoxical, it is probably the most able pupil who is likely to suffer most from the constant pressure of public examinations in the age range 15-19. Certainly it has often been remarked that a disturbingly large proportion of those who enter universities with high qualifications fail to justify their promise in the final examination for their first degree. If an able boy or girl must enter the sixth form early, and if a stay of three years is needed before university entry can be obtained, then it ought to be possible so to arrange matters that the Advanced Level examination is only taken once, that preparation for it is more thorough and less hurried than at present, and that the pupil has some leisure in which to be concerned with things outside the limits of his specialisation. One other point might be mentioned here. It is at least possible to question the wisdom of allowing a sixth form pupil seeking university entry, who has tried the Advanced Level examination once with poor success, to take it again with the same purpose in view. Very often the candidate who has needed two, and sometimes even three, attempts at the Advanced Level examination in order to attain a satisfactory standard for university entry, fails to justify himself when he has embarked upon a degree course.

Second, most of those concerned would agree that the sixth form is the proper time to begin specialised study, for then boys and girls need the intellectual challenge it provides. The real points at issue here are the form this specialisation should take, and the amount of it which is desirable. Specialisation can mean nothing more than the systematic absorption of immense quantities of factual information about a particular subject. The Advanced Level syllabuses, with their present shape, offer a strong temptation to specialise in this way in sixth forms. On the other hand specialisation can offer the opportunity to dig more deeply into a subject than has hitherto been possible in a school course, to feel the interest and excitement that comes from understanding based on larger knowledge, without having this killed by an over-accumulation of mere information and an intensive dose of spoon-fed teaching. The achievement of a proper balance in specialised study is, of course, the art of sixth form teaching; but many of those concerned must feel that to cover the Advanced Level syllabuses now prescribed leaves very little elbow room for the exercise, on their part, of sensible moderation.

The present urgent need is for schools, universities and the Examining Boards together to look carefully at the Advanced Level syllabuses. The universities should be much more ready than hitherto to say precisely what they regard as the essential things boys and girls must know in order to begin a particular degree course. Universities must also be prepared to place their requirements side by side with what experienced sixth form teachers think educationally desirable at that level. Nor must the Examining Bodies' point of view be ignored, for the problem of large scale public examining at the Advanced Level is difficult and can set its own limitations to the kind of work possible of accomplishment in sixth forms. An investigation of this kind carefully undertaken could well have surprising and encouraging results. It could lead, in some cases, to a substantial lightening of the present syllabus requirement, which would have the effect not only of allowing a more sensible kind of sixth form specialisation, but which might also contribute towards freeing sixth form time for something other than specialist study. This raises the third principle on which a better sixth form course could be constructed. It is simply that, in the sixth form, time ought to be found for the continuation and development of intellectual interests outside the proper sphere of the specialisation upon which individual pupils have embarked. This is of obvious benefit to the quality of the education provided in the sixth form. It is also clearly an advantage to those who, after a sixth form training, will enter the professions, the training colleges, business or industry. Most of all it is of manifest value to the considerable numbers who, with their sixth form courses completed, will find their way to universities.

Many readers of this article will already be familiar with the promising experimental work which has been undertaken by the N.U.J.M.B. on the provision of an examination at the Advanced Level in what, for want of a better term, is called General Studies (8). This work has proved that it is feasible to design papers and to conduct an examination at this level which will be a satisfactory test of a wide range of non-specialised sixth form work. Moreover, this can be done without prescribing detailed syllabuses, and so those who teach will be left free, in the light of their individual circumstances and interests, to devise the most suitable pattern of work for their pupils. It is, however, clear that satisfactory preparation for this examination will require something of the order of a quarter of the time available in a sixth form course of two years. No one would be so foolish as to pretend that the N.U.J.M.B.'s experiment is the only way of handling the problem of examining non-specialist sixth form work at the Advanced Level. Indeed it is to be hoped that other Examining Bodies will be moved to experiment with this problem. However, what the N.U.J.M.B. has done does show that the problem is capable of solution within the present framework of the G.C.E. examination.

Taken together, the various suggestions just discussed could be made to form the pattern of an improved sixth form course. It would be a course not radically different from that which the experience and practice of the past forty years has shown to be desirable, but it would correct what appear to many the serious faults of the present arrangement. Briefly, what could happen is this. In the sixth form, working on the assumption that the course would last for two years, a boy or girl could be asked to do general as distinct from specialist study for about a quarter of the time available. The remainder could be occupied with specialist work, based upon more satisfactory and less heavy Advanced Level syllabuses. Those going forward to universities, particularly to Faculties of Science and Medicine, would still need to prepare three Advanced Level subjects, but for the reasonably able pupil, given a reduction of the present syllabus burden, this should still be easily possible. It would mean a readjustment of university entrance requirements, but that again is not a matter of insuperable difficulty. Indeed, for the universities such an altered pattern of sixth form work would have very great advantages. Not merely would specialist preparation be better than at present, but it would be possible, with a substantial element of general training in the sixth form course, to tackle the universities' own problem of over-specialised undergraduate courses with rather more hope of success than seems likely in present circumstances. Finally, for the sixth form pupil not seeking university entry, the suggestions outlined above would allow more flexibility than at present, both in the kind of work done and in the actual subjects chosen.

This short article does not pretend to lay down a detailed programme for the improvement of the sixth form curriculum. It seeks to do no more than plead for immediate and serious attention to be given to this problem by those most concerned; namely the schools, the universities and the Examining Bodies. It is clear that it is possible to make significant improvements within the established framework of sixth form teaching and examinations. Specialist study must retain its predominant place in the sixth form course, but it could be made to serve its purpose much more effectively than is at present the case. Hitherto general, as distinct from specialist, training has not been a recognised and firmly established part of sixth form work. There would seem to be good reason now for making proper provision for it at sixth form level. This would help the universities, improve the preparation of those who pass straight from the sixth form to business, industry or teacher training, and round off grammar school education more satisfactorily than is now possible. Lying behind all this is an even more fundamental consideration. Grammar schools, the universities and the professions to-day rightly draw their recruits from the whole range of the social classes, but this has one great disadvantage of which all teachers are aware. It is no longer possible to assume, as it was even twenty-five years ago, that home influence will foster the general education of sixth form pupils. This is something for which school and university must now deliberately provide.

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ATTITUDES AND AIMS IN SCIENCE TEACHING

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INTRODUCTION

In this article we examine recent trends of opinion on attitudes and aims in science teaching in various types of secondary school, and then present evidence, derived from a questionnaire, to show what teachers declare their aims to be. Though there is some agreement among teachers of science about their aims, naturally the emphasis varies in different kinds of school. We have found a sharp contrast between the aims of science teachers as ascertained by questionnaire and those declared in recent statements by the Science Masters' Association (S.M.A.) and by various writers in the educational press.

RECENT TRENDS IN ATTITUDES TO SCIENCE TEACHING

In 1947 the S.M.A. (1) said, "The teaching of any subject at school is usually justified or defended for cultural, disciplinary and utilitarian reasons. Science can justify its inclusion in the curriculum on each of these grounds."

Recently, interest has been focused on the cultural and utilitarian aspects of science teaching, and little has been written about the study of science as a mental discipline. Modern political and scientific developments in the fields of nuclear energy and rocket propulsion have made us all conscious of the need to study science from purely utilitarian motives. "We have either got to learn physics and mathematics—or else Russian" (2).

The attitude of mind illustrated by this quip is familiar and the argument, that as a nation we must study science to survive in the modern world, is a strong one. The recent development in scientific and technological education is evidence that at last the usefulness of science and scientific method is being more fully appreciated.

Yet, at the same time, there has developed an increasing readiness to recognise that science could be a humanising study and an integral component of general education.

In a recent policy statement (3) the S.M.A. committee maintains "that science should be regarded as a central or 'core' subject in the same way as, for example, English and mathematics are at present, and as classics used to be" (p. 4). The S.M.A. now advocate that science should be taught to *all* pupils in grammar schools in such a way that it would form "part of our common cultural and humanistic heritage" (p. 3). Further stressing the cultural value of the study of science, they say "Science must be recognised and taught as a major human acitivity and as a cultural study of supreme importance because of its effects on human life and thought" (p. 11).

Others, too, have stressed the need to teach science as an integral part of a new liberal education in the modern world. In an essay on the curriculum of secondary schools Lauwerys (4) has said that although "utility has always been the chief claim of a subject for inclusion in the curriculum and we should still accept it", yet we must also "accept the idea that the sciences are capable of proving instruments not only of industrial production but also of liberal and humanistic education" (p. 9). There is also developing at the universities the recognition that science can be a humane study. An example of this trend is provided by the recent development at Southampton (5) where a course in the principles and methods of science can now be taken as an integral part of the General Honours course for the B.Sc. degree.

Another interesting example of emphasis on the cultural and humanistic aspects of science is the Northern Joint Matriculation Board's attempt to examine non-specialist studies of sixth form pupils in grammar schools by means of papers in General Studies. One of three sections of the first paper comprises questions on the concepts and principles of science. The Board's aim, so far as science is concerned, is to give credit for abilities which are not always stressed in science examinations. Questions are set which attempt "to test the ability to understand scientific information and marshal it effectively in good English" and "to test methods of scientific thinking—the ability to formulate hypotheses to account for observed phenomena, and to design experimental or other methods of testing these hypotheses" (6).

Such an examination in General Studies is, at present, only designed for, and taken by, a minority. Indeed, the developments and ideas which have been described reflect, perhaps, the beliefs and ideals of a minority of educational opinion. Yet it is an informed, progressive, influential body of opinion, and such views are likely to come more and more to the fore in the future. Little seems to have been written recently about the third possible reason for teaching science—for its value as a mental discipline. Rarely nowadays is it advocated that by learning science a boy may be trained to think logically. The inefficiency of the doctrine of the transfer of training was summarised by Sir Cyril Burt for science teachers twenty years ago (7). And as Peel (8) has said, "The teacher's task is to start from the insights of the pupils and direct them appropriately to give them current meaning—actively widening the pupils' experience. It is only under these conditions that transfer of training from science—through its disciplined method—will take place."

It is now believed that the learning in one field is more likely to be transferred to another situation if a high level of motivation is maintained and if the teacher has consciously and deliberately kept the possibility of transfer in the front of his mind and let it affect his teaching. Whellock (9) attempted to find out how far groups of sixth form students and military college cadets were trained in scientific method. His results showed that students who had done more science at school had acquired greater facility in the use of scientific method. Transfer of training, then, may take place, to some extent, in certain circumstances. Even so, writers and official bodies (such as the S.M.A.) seldom assert that science should be taught *primarily* for its value as a mental discipline. They realise the limited extent of possible transfer of training and also that, certainly for secondary modern school children, and probably for non-specialist grammar school pupils, the cultural elements in science teaching are more important.

Nevertheless, it may well be that teachers of science still hold views which might be considered out of tune with modern ideas. Sir Charles Morris (10) has said "I very much suspect that many scientific teachers may have to bring themselves to change quite radically their ideas about teaching." It is of interest to see how far modern ideas on aims and methods in science teaching have been adopted by teachers. A recent leader in *The Times Educational Supplement* (11) deplored the emphasis on mere fact in science teaching in grammar schools and implied that a year's professional training in a university education department might not make matters much better. In a rejoinder Professor Dobinson (12) agreed that excessive emphasis on mere fact was deplorable, but pointed out that the actual effects of professional training were not known. He felt that there was need for an inquiry into the whole of science teaching to see whether, as actually taught, it could be regarded as contributing to a liberal education.

AN INQUIRY INTO TEACHERS' OPINIONS ON THE REASONS FOR TEACHING SCIENCE

We can contribute some evidence by virtue of a survey carried out recently on the opinions and attitudes of teachers of science in Eire and Northern Ireland (13). In order to find out what reasons were claimed for the inclusion of science in the curriculum of secondary schools a questionnaire was constructed. Ten possible reasons for teaching science were chosen so as to cover the three groups of aims usually claimed. The aims and the groups are given in Table I. To investigate the possibility of rating the ten reasons for teaching science in order of importance a team was selected of seventeen people living in all parts of the United Kingdom and Eire,

TABLE I

POSSIBLE AIMS IN SCIENCE TEACHING

Mental Discipline	*Utilitarian*	*Cultural*
(*a*) To form habits of accurate observation	(*c*) To pass an examination	(*g*) To satisfy the child's natural curiosity
(*b*) To promote habits of clear thinking and logical deduction	(*d*) To help the pupil to decide his future career	(*h*) To develop an inquiring interest in common things and experiences
	(*e*) To give basic training for future career	(*i*) To experience the intellectual enjoyment of seeing the pattern in nature revealed by scientific study
	(*f*) To teach factual information of value in everyday life	(*j*) To ensure that modern society appreciates the significance of scientific development

each of whom had received university training in science and had proved to be experts in the teaching of school science. This team, two of whom were women, was composed of three headmasters, four senior science teachers, three university lecturers, three school inspectors, and four training college lecturers. In November 1955 these judges were invited to arrange the foregoing ten aims (14) in order of decreasing importance for three types of secondary school, grammar, modern and technical. When ranking the aims, the judges were asked to consider science teaching as it ideally should be, not necessarily as it actually is. The task of ranking was not easy and indeed had been made deliberately difficult so that no obvious "ready-made" answers should be discernible. It was essential, however, that notwithstanding the difficulty, the judges should be in a certain measure of agreement. The amount of agreement was measured by calculating the coefficient of concordance (W) (15). The values of W for the three groups of secondary schools are given in Table II. As the results were significant at the 1% level of probability, the questionnaire was sent to half the secondary schools in Ireland. In all 402 schools were approached, 332 in Eire and 70 in Northern Ireland. Of the questionnaires distributed 64% were returned in Northern Ireland and 37% in Eire. The lower percentage of replies from Eire was mainly due to the fact that science is not taught in many of the girls' secondary grammar schools. Though some "No Science" replies were received the majority of this type of school ignored the request for information. The replies from the schools were divided into five groups. 1. Eire Grammar, 2. Eire Technical and Vocational, 3. Northern Ireland Grammar, 4. Northern Ireland Technical, 5. Northern Ireland Secondary Modern (16), and for each group the coefficient of concordance (W) was calculated and proved significant at the 1% level of probability. The results provide evidence that teachers, as well as the judges, agree to some extent among themselves as to why they teach science. (See Table II).

As there was a significant measure of agreement among the judges a ranking based on the combined estimates of all the judges could be taken as a best ranking. Similarly there was enough agreement between teachers to make a combined estimate possible. Table III gives the pooled rank order for the ten aims for both judges and teachers.

The amount of agreement between teachers and judges was measured by means of a rank order correlation coefficient. The values obtained are given in Table IV.

TABLE II

COEFFICIENT OF CONCORDANCE FOR JUDGES AND TEACHERS

	Type of School		
	Grammar	*Modern*	*Technical*
Judges	0·347	0·560	0·282
Eire Teachers	0·274	—	0·340
Northern Ireland Teachers	0·333	0·708	0·455

TABLE III

POOLED RANK ORDER OF AIMS

	Type of School							
	Grammar			*Secondary Modern*		*Technical*		
Aim	*Judges*	*Eire Teachers*	*N.I. Teachers*	*Judges*	*N.I. Teachers*	*Judges*	*Eire Teachers*	*N.I. Teachers*
a	2	2	2	3	4	3	3	4
b	1	1	1	5	5	2	2	3
c	10	7	6	10	10	10	8	5
d	8	6	7	7	9	4	6	7
e	9	4	4	8	8	1	1	1
f	6	3	5	4	3	6	5	2
g	7	9	8	2	2	8	10	8
h	3	5	3	1	1	5	4	6
i	5	8	9	9	6	9	7	9
j	4	10	10	6	7	7	9	10

(See Table I for description of aims)

TABLE IV

CORRELATIONS BETWEEN JUDGES AND TEACHERS

School Group	*Correlation*
Eire Grammar	0·39
Eire Technical	0·87*
N.I. Grammar	0·42
N.I. Modern	0·90*
N.I. Technical	0·62†

*Significant at the 1% level

†Significant at the 5% level

The ten possible aims in science teaching can be considered as falling into three broad categories, mental discipline, utilitarian, and cultural. The aims can be pooled into these three categories and average rankings (17) calculated both for judges and teachers. The results obtained are given in Table V (Judges) and Table VI (Teachers).

TABLE V

Pooled Average Rankings for Judges

	Type of School		
Aims	*Grammar*	*Modern*	*Technical*
Mental Discipline (*a*) (*b*)	1·5	4·0	2·5
Utilitarian (*c*) (*d*) (*e*) (*f*)	8·25	7·25	5·25
Cultural (*g*) (*h*) (*i*) (*j*)	4·75	4·5	7·25

The figures show clearly that, for all types of school the judges put mental discipline reasons for teaching science first. In grammar and modern schools the cultural aims are second and the utilitarian aims last. In the case of technical schools the utilitarian aims take precedent over the cultural. It should be pointed out that one of the utilitarian aims, "To pass an examination", would naturally be rated low by the judges. This particular aim was included chiefly to see how the teachers would react to it. If this aim is omitted, the average rankings for the utilitarian group of aims fall to 7·7 grammar, 6·3 modern, and 3·7 technical, but the same order is preserved.

For simplicity in the pooled rankings for teachers the Eire and Northern Ireland schools were combined.

TABLE VI

Pooled Average Rankings for Teachers

	Type of School		
Aims	*Grammar*	*Modern*	*Technical*
Mental Discipline (*a*) (*b*)	1·5	4·5	3·0
Utilitarian (*c*) (*d*) (*e*) (*f*)	5·25	7·5	4·38
Cultural (*g*) (*h*) (*i*) (*j*)	7·75	4·0	7·88

DISCUSSION OF RESULTS

1. There was unanimity between the judges and the teachers as to the most important single reason for teaching science in each type of school. In grammar schools it was one of the mental discipline aims (*b*), "To promote habits of clear thinking and logical deduction." In technical schools it was one of the utilitarian aims (*e*), "To give a basic training in preparation for future career." In secondary modern schools it was a cultural aim (*h*), "the development of an inquiring interest in common things and experiences."

2. When broad classes of aims were examined the claims for the study of science as a mental discipline were high for all groups. It is quite clear that the teachers and judges believe that the chief value of science teaching (particularly in grammar schools) lies in its ability to train for accurate observation, clear thinking and logical deduction.

3. There was less agreement among science teachers in grammar schools about the aims of their work than was the case in modern and technical schools.

4. The correlation between the rating of aims by judges and teachers was rather low for grammar schools due to the judges placing cultural aims before utilitarian ones whereas the teachers took the opposite view.

5. Only in Northern Ireland grammar and technical schools was the learning of science so that an examination may be passed considered to be a fairly important aim. No doubt the teachers were being quite realistic for examinations continue to have a prominent place in these schools.

6. The most striking result of the inquiry was the high coefficient of concordance among both the judges ($W=0{\cdot}560$) and the teachers ($W=0{\cdot}708$) for secondary modern schools, and the remarkably high correlation ($R=0{\cdot}903$) between the two rank orders of aims. These results have a bearing on the question raised in *The Times Educational Supplement* (18) on the value of professional training for science teachers. The majority of teachers in the secondary modern group had qualified since 1950, by taking the one year post certificate course in science at Stranmillis Training College, Belfast, where one of us (J.F.K.) was in charge of the course. These teachers seem to have been greatly influenced in their aims by the training received, they agreed on the importance of developing curiosity and interest, and their views corresponded closely to those of the judges. Here at any rate, is some evidence of the kind looked for by Professor Dobinson

in his letter to *The Times Educational Supplement*. Apparently teachers' attitudes and opinions can be modified by their teacher training course and these attitudes are maintained after experience in schools.

7. The judges were not prepared to recommend that in technical schools the useful aims should be given the emphasis they received by the Northern Ireland technical teachers, and as a result the rank correlation coefficient was rather low and barely statistically significant. The agreement between the judges and Eire technical teachers was much closer.

8. It has been pointed out that mental discipline claims are unfashionable in to-day's climate of opinion yet the teachers (and indeed the judges too) continue to say that the fact that science can train the mind is an important reason for teaching it in our grammar and technical schools. Such evidence as there is (19) suggests that transfer of training is unlikely to take place unless the teaching positively encourages it. The method of teaching which might enable science to train the mind would presumably be the inductive "let's try to find out" type of lesson rather than the deductive "I'm telling you" approach. Yet in another part of the questionnaire (referring to methods rather than aims) half the teachers admitted that they usually gave the facts of the lesson to the class and then, *if possible*, verified them by experiment. Further, two out of three teachers used the science note book for dictating theory notes, the pupils writing up their own practical work. The methods in use by the majority of teachers do not seem particularly well adapted to their professed aim of teaching science for its value as a mental discipline.

CONCLUSIONS

There is to-day an increasing need to recognise science as a humanising study and a component of general education. We can no longer afford to accept the dichotomy between science and humanism and it is clear that we need to examine carefully our aims and methods in the teaching of science in all types of school. This investigation has shown that in Ireland teachers rate highly the claim that science teaching can be justified for its value in forming habits of accurate observation, clear thinking and logical deduction. Only in the group of secondary modern teachers, who have been trained recently, do we find close agreement between their aim in the teaching of science for its cultural value and the general trend of informed opinion. We do not say categorically that the study of science cannot train the mind, but we do say that the wise teacher would do well to examine his methods carefully if he teaches with this end in view. Further, it would be unwise to ignore the trend towards the teaching of science in such a way that it can be regarded as a part of a liberal and humane education. It is possible that teachers of science in Great Britain might have more liberal attitudes and opinions than their opposite numbers in Ireland. More of them (particularly in grammar schools) take a course of professional training. We hope to repeat the experiment (with an improved questionnaire) in Great Britain to see if similar results are obtained. Such an investigation may give part of the answer to the difficult question as to whether teachers' attitudes and opinions can be permanently influenced by courses of professional training.

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15. See Kendall, M. G., *Rank Correlation Methods* (Griffin, London, 1948), Ch. VI; Moroney, M. J., *Facts and Figures* (Penguin, Harmondsworth, Middlesex, 1951).

    The coefficient varies from zero, representing no agreement, to + 1·0, representing perfect agreement. Significance tests can be carried out to estimate the probability that any given value could have occurred by chance.
16. Using English terminology; secondary modern type schools in Northern Ireland are known as intermediate schools.
17. There are objections to the pooling of rank orders so the procedure should be regarded as a rough method of illustrating the underlying differences. No statistical exactitude is claimed for these figures.
18. op. cit., 10th January and 31st January 1958.
19. See *Encyclopaedia of Educational Research* (1958), p. 1488.

BOOK NOTICES

READING AT HOME AND ABROAD

W. S. Gray, *The Teaching of Reading and Writing* (Unesco and Evans, 1956, 18s. 6d.).

M. D. Vernon, *Backwardness in Reading* (Cambridge Univ. Press, 1957, 25s. 0d.).

J. T. Goins, *Visual Perceptual Abilities and Early Reading Progress* (No. 87 Supplementary Educ. Monographs, Univ. of Chicago Press, 1958, 16s.).

J. C. Daniels and H. Diack, *Progress in Reading* (Univ. of Nottingham Institute of Educ., 1956, 3s. 6d.).

The school subject which has the greatest number of research studies to its credit is undoubtedly reading. Future research workers in this field will find both Professor Gray's and Professor Vernon's books indispensable and complementary sources for reference on work done and on problems needing further investigation. Teachers will perhaps find the survey of current methods of teaching reading together with evaluations of their respective advantages and disadvantages of greatest interest; again the accounts presented by the two authors are in many ways complementary.

The sub-title of Professor Gray's book, *An International Survey*, indicates its nature and purpose: to analyse and describe the various methods used at present in teaching both children and adults to read and write and to evaluate their effectiveness as far as available data permit; to discuss ways of improving the teaching of reading and writing; and lastly to define problems which need further study in order to promote literacy throughout the world. Thus an international perspective is the keynote and attention is mainly focused upon the problems of the underdeveloped areas. "This study does not suggest new methods of teaching reading and writing . . . it sets out rather to appraise past and present practices." Though well documented by references to research results, detail and depth must, in a survey of this kind, inevitably be subordinated to broad generalisations.

Professor Gray points out that literacy, like so many other educational and psychological concepts, only becomes meaningful when considered within the framework of the socio-economic, political and cultural demands and expectations of a community. He suggests that "a person is functionally literate when he has acquired the knowledge and skills in reading and writing which enable him to engage effectively in all those activities in which literacy is normally assumed in his culture or group". If such a definition seems to beg the question, it must be remembered that "few studies have been made to discover the types and levels of efficiency in reading and writing that modern life demands". Viewed internationally, the problem is enormous. "Training is required for at least half the children and adults of the world. In addition, further training is needed for millions of children and adults who at some time have attended school or adult classes, but are not as yet functionally literate." The first four chapters are devoted to general considerations such as the role of reading and writing in fundamental education and the nature of the reading process in various languages. More than two-thirds of the book deals with the various methods of teaching reading and writing to children and adults, and possible ways of organisation. Some of the latter are perhaps too general for teachers in this country; however, the emphasis, especially in the last section, "Action Required", is on literacy in underdeveloped countries. Yet Gray's conclusions regarding the chief trends which have emerged from research on methods of teaching reading and writing are as topical and applicable here as elsewhere. A full alphabetical list of references at the end would considerably add to the value of this survey as a source book.

Professor Vernon devotes herself to the problem of reading backwardness in childhood. It is a scholarly and important work which will remain a standard source of reference for many years to come. "The main study of this book centres upon the illiterates—those who for some reason or other are unable to master even the simpler mechanics of reading."

In the first two chapters the early development of visual and auditory perception is outlined together with the role which these perceptual processes play in learning to read. The following four chapters deal with the nature of reading disability, reviewing firstly the contribution made by visual, auditory, speech and cognitive difficulties and defects. Then Professor Vernon considers "whether any more fundamental cause of the disability can be detected, studying first those causes which may be innate, and secondly those which are the result of the child's upbringing and environment". Perhaps at least one ghost will now be laid for ever by the authoritative and categorical statement that "no child exhibiting reading disability should be stigmatised as suffering from an irremediable defect labelled 'congenital word blindness' (except in cases of cerebral injury)". The final chapter on the cure of reading disability is regrettably brief. The five case studies quoted by Professor Vernon in an appendix are even briefer and this is all the more to be deplored in view of her own statement that "the only really satisfactory method of making this investigation [into the underlying causes of reading disability] is the intensive study of individual cases".

The vast literature is systematically reviewed with great thoroughness and research evidence is appraised with considerable impartiality. However, the author's bias is indicated by the relative weight accorded to each topic: visual and auditory perception in reading generally and in the backward reader specifically take up some sixty-four pages, while "defects of personality", both innate and acquired, occupy sixteen pages; similarly, to confine a discussion of the role of intelligence to a mere three pages, while devoting twenty-nine to theories of "cerebral dominance", seems, at least to this reviewer, a curious inversion of the relative importance of these two topics. Perhaps the inconclusive and rather conflicting evidence decided Professor Vernon to make this topic the longest single section of her book. From a practical point of view, however, this seems hardly justified.

The book as a whole is admirably clear and readable, and the lay-out is conducive to easy reference. Some rather important assertions, however, are unsubstantiated or even contradictory; for example, what is the teacher or research student to make of these statements: "It seems fairly clear that many of these illiterates, and especially the older ones, can be detected by the use of adequate reading tests, provided that their actual reading age is ascertained"; "There is no doubt that these cases do present, *at least superficially* [my italics], a great and complex diversity of features"; "There must also be numerous cases, at least in this country, in which reading disability is not detected until the child reaches the secondary school stage at the age of 11 years, and perhaps not even then"? Possibly not treated, but surely at least detected? Again, it is difficult to see on what grounds Professor Vernon concludes that boys merely *appear* [my italics] to be slower than girls in learning to read. Most research findings (including those quoted by the author herself) clearly show that girls, at least until the age of 11 years, are in advance of boys, while the latter predominate quite significantly among backward and illiterate readers. This greater incidence is acknowledged by Professor Vernon herself when she, somewhat paradoxically, refers to it as "one of the most curious facts relating to reading disability."

The book succeeds, however, in its main aim "to make a thorough and detailed study of the experimental investigations that have been made; and to present and to weigh up the evidence as to the importance of the various factors which appear to be associated with the inability to learn to read". Thus this survey is a valuable contribution to the field of educational psychology.

Miss Goins reports the results of an experimental study which had two purposes: to ascertain the level of competence in visual perception of first-grade children and the correlation of their perceptual abilities with their achievement in reading; and secondly, to determine the effect that training in recognition of visual forms would have on progress in learning to read. "A battery of 14 visual perception tests as well as intelligence and reading tests was administered to 120 children (mean age 6 years 3 months)."

A tachistoscopic method was used in the perceptual training. The experimental procedures and tools are clearly described and the findings are presented and discussed in detail. On the basis of her evidence, the author claims that "six relatively simple tests of visual perception may ascertain early and easily the pupil who is able to take advantage of modern methods of learning to read (i.e. word, phrase or sentence method). Conversely, the tests may identify those pupils requiring other types of instruction." The data revealed a multiplicity and range of visual perceptual abilities. The results of the tests also showed significant correlations with later success in reading. Perhaps it should be mentioned that none of the perceptual tests had any reading or verbal content. Tachistoscopic form training improved visual skill for most of the children who were initially good readers, but the poor readers profited little from the training; nor was reading progress itself influenced by it. Thus this study confirms the differentiation and variability of visual perceptual processes and refutes a narrowly conceived theory of transfer of training in the field of visual perception.

The monograph *Progress in Reading* stands in marked contrast to the one just reviewed. The authors claim that their modified phonic method achieved results significantly superior in every way to those attained by mixed methods of teaching reading. However, the exact nature of the latter method used in the experiment, the books and materials, etc., remain unspecified. The criteria used for evaluating this superiority seem rather narrow, namely, word recognition skills; moreover, the tests for measuring these were specially constructed for this investigation and their content would appear to favour the group taught by the authors' own method. The experimental samples of 7- to 8-year-old reading failures were equated for age and home background but not for intelligence; for one year forty-four children were taught by the phonic method used in the *Royal Road Readers* (also devised by the authors) and fifty-five children were given remedial work based on mixed methods. The authors personally supervised the teaching given to the first but not to the second group, and it cannot be judged therefore whether an untutored teacher could apply the modified phonic method with the same efficacy. While the claims made for this method are impressive, much further study—preferably by independent uncommitted experimenters—is required to substantiate its superiority over other teaching methods. At the same time, one welcomes any new approach which can be used for remedial work since a different method and a new series of readers have in any case a therapeutic effect on the discouraged and failing pupil.

M. L. Kellmer Pringle

NEW TRENDS

BRIAN SIMON (ed.), *New Trends in English Education* (MacGibbon and Kee, London, 1957, 25s.).

THE "new trends" are the unstreaming of the junior school, the entry of secondary modern pupils for external examinations, the introduction of the comprehensive school, and the evolution of a common curriculum. Mr Simon lists them in his introduction, and gives a useful survey of the customary arguments against the present tripartite system in education —the unsatisfactory nature of the eleven plus examination, the frustration and sense of failure suffered by those children who do not pass it, the general adverse effects on the majority of children of a system geared to "academic" requirements, which fails to teach them the skills they need on the theory that they cannot master them. The problem, as Mr Simon sees it, is "*how* to provide all children with the knowledge that a citizen of the modern world must have".

Unquestionably he is right about this, and it is heartening to read in many of the articles, all of them by practising teachers, how this is being accomplished. Their tone is generally optimistic, but there is no attempt to gloss over the difficulties; there is no uniformity about their approach, which has usually grown out of different conditions and needs. Perhaps the most effective article, however, is that by Edward Blishen, which is a story not of success but of failure. Mr Blishen offers no solution—he merely describes how soon the old elementary school buildings, and the North London slum environment, extinguish any sparks which appear in his pupils. But it is not only the environment which is at fault; the secondary modern school, by being too decided on its own scope, has imposed a feeling on the pupils that they are in a lowly educational compartment where ambition is out of place. Of the existence of a considerable potential, as yet largely unassessed, he has no doubt; and his conviction is shared by the other contributors to the book, who "refuse to confine their pupils in a definition". As Miss M. D. Clarke writes of Peckham Secondary School: "Given a permissive atmosphere, the avoidance of prejudgment, the maximum of freedom and opportunity, confidence in their own powers, we cannot tell what may be achieved."

With this attitude goes a criticism, often implicit, sometimes quite open as in the article by Miss H. Wolff, of educational theory which begins with presuppositions about the "nature" of children. The emphasis in this book is rather on the goal towards which children must strive—the "hurdle", the standard, the external examination—and one welcomes this recognition that it's dabbling in the Dewey leaves the mind too bare.

And yet reactions against "nature" can go too far. Mr B. J. Howell Eaton begins his article by quoting Nunn's famous words that the aim of education should be to help boys and girls to achieve "the highest degrees of individual excellence" of which they are capable; but to some of the contributors individual development is unimportant; "social unity" is all important. Possibly they would deny this, but the whole bias of their argument makes the conclusion irresistible. Take for instance the article with which the book opens, "The unstreamed junior school". The writer, Mr G. C. Freeland, has unstreamed the school of which he is head, and has divided the classes on the basis of age, in years and months ("I cannot agree that the IQ is a significant measure of anything"). This means, of course, that the bright and the dull children are taught together, for in such conditions "the best class spirit develops" and standards "as a whole" are raised. The phrase "as a whole" constantly recurs in the article, significantly enough—Mr Freeland is even uneasy about children of similar ability within the forms working as groups, though some of his teachers persist in using this unsocial method. It is difficult to see how, on the basis of his arguments, he can justify the use of a remedial teacher in his school, or the transfer he mentions of an E.S.N. child to a special centre. The doubts that arise in the reader's mind about the effects of unstreaming on the brighter children are not set at rest by Mr Freeland's assurances.

Take arithmetic, for example. "The class is taught new arithmetical processes as a whole," and, we are assured, "this system works well. The quicker children are not held back but explore more widely on a given level, so establishing a solid foundation. The slower children proceed mechanically through the syllabus. . . ." "Explore more widely on a given level . . ." is Mr Freeland's way of putting what might more frankly be called marking time; and if these quicker children need it to establish "a solid foundation" what about the slower ones? The arithmetic syllabus, says Mr Freeland, is "by no means over ambitious". That would seem to be an understatement.

The theory of "social unity" is again seen to cut across purely educational considerations in an article by Messrs Brown, Dixon, and Wrigley, on a common English syllabus in the comprehensive school. The reason advanced for such a syllabus is that it is "necessary if all our pupils are to enjoy the same opportunities". This has a fine ring about it, until one remembers that the aim of English teaching is to produce people who can read and write and speak properly, and the use of the same text book by all the children will be no help here if it is far too easy for some and far too difficult for others. (It is in any case rather sad to note the importance the writers give to the text-book; they mention no literature except the extracts it contains.) To imagine that the "same opportunities" will accrue to children from their studying the same book, rather than from helping them to improve their English having regard to their differing abilities, is to confuse means with ends.

This book then, is at once encouraging and disturbing; encouraging because it shows in the articles of some of the contributors a determination to develop the individual capacities of children, and not to be blinded by theory or prejudgment; disturbing because in the articles of others it shows just the opposite—the construction of systems for children "as a whole", like the old army uniforms which fitted everybody (in places) and nobody properly. *New Trends in English Education*, the editor tells us, is "a book written by teachers themselves for all who are concerned with the future of education; including parents". From it they will derive a clear picture of what is going on at the present time in the more thoughtful of our "new trend" schools.

A. M. WILKINSON

A WELL-TUNED QUARTET

L. W. DOWNES and D. PALING, *The Teaching of Arithmetic in Primary Schools* (Oxford University Press, 1958, 15s.).

N. M. BARNETT, M. G. FAITHFULL and T. R. THEAKSTON, *Juniors Learning Mathematics* (Educational Supply Association, 1956, 8s. 6d.).

E. J. JAMES, *The Teaching of Modern School Mathematics* (Oxford University Press, 1958, 21s.).

INCORPORATED ASSOCIATION OF ASSISTANT MASTERS IN SECONDARY SCHOOLS, *The Teaching of Mathematics* (Cambridge University Press, 1957, 15s.).

MUCH has happened in the development of mathematical education during the present century, if we may conveniently mark the time from Professor Perry's address to the British Association in 1901 and the first appointment of a Teaching Committee by the Mathematical Association in the following year. With the steady growth of education generally at all levels and the increasing number of people engaged in it professionally, a vast amount of experience, experiment and discussion has enriched our understanding and practice. These four recently published books embody much of this work and thought, and together afford a wide survey of methods, aims and trends in the whole range of mathematical education from the nursery to the threshold of the technical college and the university.

In over-simplified terms it may be said that the main emphases now are on the danger of an excess of formal work with symbols or concepts that are inadequately grounded in practical experience, on the importance of relating theoretical work where possible to practical results, and on the choice of topics that are relevant to present-day life and society. Instead of being content merely with correct formal work, we aim for a real understanding of the mathematical principles behind it, over a wider range than has been customary in the past. Our success in this, of course, will vary with pupils of different ability, and content and method will need to be varied accordingly. It might well be considered impossible to deal with the needs of all children in a single study of mathematics teaching, and a universal answer is not possible on the correct balance between formal work and insight into principles.

The Teaching of Arithmetic in Primary Schools was commissioned by

UNESCO, and so is designed for a wider public than teachers within the well-established educational system of this country. It is, none the less, an admirable handbook for use here, stimulating thought, suggesting a rich variety of methods and giving full and careful tabulation of the steps to be covered in each topic. Teachers are challenged to examine their habitual routine procedures, and by the effective device of being asked to learn a new set of number words, signs and rules they are put in the child's position of bewilderment when faced with a new symbolism or terminology. The child's necessary background of experience for the concepts is emphasised, the necessary memorising work that must be done regularly—with innumerable practical suggestions for making it enjoyable, the careful analysis and grading of steps, and the need to apply facts and methods to actual problems. The authors also advocate the extension of work beyond the traditional arithmetical topics to geometrical and graphical ideas, and aim to stimulate both teacher and pupil to begin to think about more advanced topics.

Juniors Learning Mathematics, imbued with the same spirit, is able to develop the content a little further. There is the same important emphasis on the necessary combination of practical experience, memory work that can be enjoyable, the grading of steps, and applications. The teacher is challenged to give practical interpretations to his familiar symbolic expressions (e.g. in the multiplication and division of fractions). So strong is the dulling effect of habit that this experience is strenuous, but the reader grows thereby in critical ability sufficiently to perceive a few rare lapses on the part of the authors from the high standard they set themselves. As the title indicates, it is urged that junior school work should be wider than mere arithmetic, and plenty of historical and problem material is given to help broaden the teacher's own view of his subject and enrich his lessons, particularly with the abler children.

The Teaching of Modern School Mathematics has a particular significance in this group of books as illustrating the overlap that is necessary and desirable in our educational system. The basic work covered in *Juniors Learning Mathematics* is to be found here again, with the needs of the weaker children in mind, and the more advanced material of the previous book is still relevant for the average and abler pupils. The course for these abler pupils, in its turn, overlaps with those of the grammar and technical schools, and certain sections from algebra, geometry and trigonometry are appropriate. An important principle emphasised here is that even where traditional sections of theoretical work are not appropriate, it is possible to study topics in a more practical way but so as to develop a genuine understanding of mathematical ideas. The organisation of several topics with various levels of intellectual content is described with many valuable suggestions. The most extensive of these are surveying and astronomy, and in the latter it is shown strikingly how a simple study of the length and direction of shadows throughout the day and throughout the year can introduce important mathematical ideas and use a variety of methods which will unify different branches of the subject.

The Teaching of Mathematics is written by a committee of teachers of wide and varied experience, and is concerned mainly with the grammar school, though it also outlines the previous work of the primary school and discusses the standard of attainment to be expected at the age of transfer. It describes the changes of the last forty years, and the choice of topics discussed later in the book is clearly designed to influence further change in directions considered desirable. To describe the course of teaching with the fullness of the more elementary books would take it to an inordinate length, and it therefore assumes a fairly detailed knowledge of the content of the course on the part of the reader, except where in a few places it is desired to initiate or accelerate a trend, such as the teaching of statistics or the earlier teaching of calculus. It is good to foster these trends at the present time, though soon it may be seen to be necessary to give renewed attention to formal aspects of the work. Drill and memory work are equally important elements here as in the primary school, and secondary school teachers may find that they can learn much from the careful planning of such work by their junior partners. In discussing the reasoning behind a symbolism they can also learn something from the two books here concerned with junior school work. There seems a danger, for example, that the sound treatment of the multiplication and division of fractions, mentioned above, may suffer neglect through its falling in the gap between junior and grammar school, and not being fully covered in either.

In spite of the fact that the ultimate aim in grammar school teaching is to build up a much more elaborate and formal structure of mathematics than in the other schools, there is a surprising uniformity of spirit in all these books. Two quotations from the present book will illustrate this. "A cardinal defect of much mathematics teaching is the tendency to hurry on too quickly to 'sums' whilst ignoring concepts and realities." "Mathematics should be created *after* the need for it has become apparent." (This is a worthy sentiment even if it is not always possible to satisfy it at our present pace in education.) Another aspect of this agreement appears in the threefold concern with theoretical content, practical details of teaching and material apparatus. Further, all these books aim to deepen the understanding of their readers and extend and enrich their knowledge of the subject beyond the level at which they teach.

In view of the widely expressed criticism of school mathematics teaching it is encouraging to read such a set as these of independent yet harmonious books written with such breadth of view and penetration. Unfortunately, these books alone will not ensure perfection in mathematical education. There is also required a sufficiency of teachers who are aware of the increasing demands being made of them and are responsive to these ideas. A gradual improvement in the quality of teachers is perhaps all that can be hoped for, but to this improvement, both of present and future members of the profession, these books will make a significant contribution.

W. O. STORER

W. M. O'NEIL, *An Introduction to Method in Psychology* (Melbourne University Press, 1957, 25s.).

PROFESSOR O'NEIL has written this book because he believes that although many good introductory texts give the content of psychology, none of them bring out effectively how psychological facts have been established. Accordingly his first chapter describes in some detail Boring's experiments on the Moon Illusion—the fact that the moon when it is near the horizon appears much larger than when it is well up in the sky—and also, a very different psychological problem, the development of factor theories to account for the correlations between mental tests. These two examples of psychological investigation are used to illustrate the cycle of observation—hypothesis—inference and observation which characterises all scientific investigation.

The book is an attempt to combine logic and psychology. The second chapter sets out the traditional philosophical logic of propositions, formal relations and inference. Drawing illustrations mainly from experimental psychology, the roles of hypothesis and experiment are examined. Other chapters are devoted to case study and survey methods, psychological measurement, the reliability of data, the testing of hypotheses, Mill's canons of inductive inference and the hypothetic-deductive method.

Professor O'Neil has succeeded in presenting a most valuable and unusual synthesis of psychology and logic. At the same time the book seems to the present reviewer to take for granted much more background information than beginners are likely to possess, and to be more suited to the needs of graduate and research students in experimental psychology.

H. MADDOX

BRIAN SIMON (ed.), *Psychology in the Soviet Union* (Routledge, London, 1957, 32s.).

THIS book consists of 20 papers by contemporary Soviet psychologists. They cover the main fields of psychological research and thinking in the Soviet Union. These fields are limited in the main to general psychology, especially sensation and perception, and to child psychology, with the emphasis on education and training. Mental tests and social psychology are proscribed, and personality study as yet undeveloped.

In 1950 Soviet psychologists were directed to base their work on that of Pavlov, and many of the articles on general psychology are concerned with the bearing of Pavlovian physiology on psychology. One paper summarises the experimental evidence concerning conditioned reflexes in children. Other papers describe the increase in visual sensitivity following conditioning procedures, the formation of motor habits in young children and the role of language in children's learning.

Another section includes three papers on perception and memory: an essay on spacial discrimination, a study of memory in the light of Pavlov's teaching, and an experimental study of the influence of experimental instructions on the formation of associations.

The section on child and educational psychology may be of some interest to teachers. It includes a study of the main stages of assimilating concepts in various school subjects. In an investigation of geometry teaching, for example, it is shown that visual material must be varied to guarantee a correct mastery of concepts. Another article stresses the value of the study of the child's perceptual activity. Remedial measures in arithmetic are described in some detail in another paper on educational backwardness.

The book concludes with three theoretical articles, including a discussion of the use of introspective methods in psychology, and of the relationship of psychology to physiology.

All these papers are difficult to understand, not only because of differences in concepts, vocabulary and methods, but because the authors frequently find it necessary to stress their orthodoxy or to belabour theoretical issues which are of little concern outside the Soviet Union.

H. MADDOX

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EDITORIAL

TIME-WORN adages lose their value: we may no longer assume that "what goes up must come down", and perhaps we should view with equal caution the assertion that "truth will out". In the second Annual Institute of Education Lecture, which we publish in this issue, Dr Bronowski discusses the search for truth which has been the dominant activity of our civilisation since the Renaissance. Most people would agree that science is concerned with truth, but Dr Bronowski goes further. "Truth", he maintains, "is the only sound foundation of a democratic society", the only basis upon which we can establish mutual trust in matters both large and small. Not all societies hold "truth to fact" as an overriding value; but as a basis for scientific progress, and as a common standard for our own form of society, it is essential. At a time when many other sources of values have been challenged it is salutary to be reminded that science, and our social structure, imply a value of this kind.

Mr Gaskin writes on the future of the grammar school and, almost inevitably, touches on the relation between our system of education and our form of society. The problem of maintaining and raising standards of learning, and at the same time inculcating the necessary social attitudes, is at the root of many educational disputes.

Morant, in so far as any of the credit may be given to him, was successful in a manner he perhaps hardly expected. In helping to lay the foundations of our grammar schools as they exist to-day he both solved a problem for his generation and provided one for ours. Whatever their declared functions at the beginning of the century, and whatever other purposes they have served, it has been shown that the grammar schools act effectively as a means of education for and recruitment to what is popularly called the "middle classes". One of the arguments used against them, in fact, is that they perform this particular function too well: it is complained that children's future careers are determined at the age of eleven, divisions between the social classes are perpetuated, and the next generation of trade unionists will be starved of its natural leaders.

There are bitter differences of opinion as to what should happen to the grammar schools, but Mr Gaskin makes a point deserving universal support: their tradition must continue—and this applies particularly to their tradition in maintaining high standards of learning. The fact is that grammar school education has, broadly speaking, been very successful in providing us with professional, technical and administrative workers of all kinds, including the majority of our scientists. But the demand for such workers is increasing and there is a need for more highly developed abilities throughout our society. As in 1902, changes in our form of education appear inevitable. They must be changes which, among other things, raise the general level of learning in our whole population, especially in the fields of mathematics, science and technology. The fifth Institute Summer School, of which particulars appear elsewhere in this issue, deals with this problem. It is apparent that we shall soon have much greater diversity of secondary education with greater opportunity for more children to proceed to G.C.E. We hope for this reason to include in future issues some discussion of the developments now taking place in secondary modern schools. During recent years much attention has quite rightly been paid to the needs of subnormal children; perhaps we are now due to discover the reserves of talent in ordinary children.

It is a truism that as the level of university education depends at present upon the grammar schools, so the level of grammar school education depends upon the primary schools. In the grammar schools during the reign of Elizabeth I many pupils were taught no written arithmetic; the subject was taught to scholars intending to enter a university but even they, at the end of a school career, might find it difficult to read page numbers, let alone perform such operations as addition and subtraction. No-one suggests that the relegation of the four basic rules to the eleven-plus is due entirely to the efforts of our primary school teachers, but one often feels that, within the limits in which they work, their efficiency is quite remarkable. Some teachers of juniors, however, believe that these limits are too narrow. It is asserted that in arithmetic, for example, there is too much computation and insufficient teaching of mathematical ideas. There is little doubt that junior school teachers have felt restricted by the demands of the eleven-plus examination. A gradual liberalising of this examination will allow greater freedom of syllabus and a greater opportunity to teach mathematical ideas through practical work.

H. J. HALLWORTH

THE SEARCH FOR TRUTH⑴

by J. BRONOWSKI
Director, Coal Research Establishment, National Coal Board

I

IMAGINE yourself three hundred years ago setting a puzzle to the poet John Milton. The year is 1658, it is high noon on a sunny day, and you ask him, "What would happen if the sun were snatched out of the sky at this instant so that it disappeared totally?" Milton was blind then, but he would answer without hesitation, "It would get dark." If you pressed the question and asked him, "How soon would it get dark?" he would hardly understand you. "Why, naturally, it would get dark at once," he would say. And if you were to go on to ask him what else would happen if the sun were suddenly to disappear, he would become impatient. In 1658 it was known that the sun gives light, and no other effect was known; for example, it was not known that light travels at a finite speed.

All this changed within a few years, almost before Milton died. Isaac Newton realised, while he was still a young man at Cambridge, that the sun also exerts a pull of gravitation which holds the earth in its orbit. Ole Römer conceived the idea that light moves at a finite speed. These discoveries were not published at once, and when they were it took time before they became widely known. But if we step forward fifty or a hundred years, we can be sure that some of the new conceptions were known, even to a poet with no interest in science.

Imagine yourself then a hundred years later, in 1758, putting to the poet Thomas Gray the question which you once put to Milton. Like Milton, Gray would know that if the sun were to disappear from the sky at noon, the earth would grow dark. And Gray might know what Milton did not know, that it would not grow dark at once. Since Gray was a Cambridge don, he might even be more exact, and might know that it would not grow dark for several minutes—for Römer's estimate of the speed of light, although not very accurate, did say that light takes minutes to get from the sun to the earth.

Certainly Gray would know, as Milton did not, how to answer your further question, "What else would happen?" The fame of

Newton had made this familiar, and Gray would answer with assurance, "The earth would fly out of its orbit." But if you pressed the question and asked, "How soon?" Gray would be as puzzled as Milton was, and would have no answer but, "At once." It did not occur to anyone in 1758 that the earth might go on feeling the pull of the sun's gravitation for any time after the noon catastrophe.

The last question has been answered only in our own century by the theory of Relativity: we now know that the earth would take time to fly out of its orbit. For the theory of Relativity says that light is the basic signal which links all the events of the universe together, and this implies that no influence can pass from one body to another faster than the speed of light. We owe this insight into the connexions between events to Albert Einstein, and although it has taken a long time to spread, it ought now to be understood by every educated person. I hope that modern poets are as educated in this as they should be, and that they know the strange relations by which the universe is linked together. If then you were to put to T. S. Eliot the questions which you once put to Milton and to Gray, his answer should be (and I hope it would be) richer than theirs. In 1958, Eliot can say what Milton and Gray could not: that if the sun were snatched out of the noon sky instantly and totally, the earth would grow dark and would fly out of its orbit, both at the same moment—a little over eight minutes past noon.

II

I begin with this fanciful story, part fable and part history, because the progression it describes is characteristic of science. There has been progress between 1658 and to-day; we know more now about our relation to the sun than we did then; but what we know is not at all (as it seems to the outsider) a string of additional facts. The non-scientist is tempted to picture the scientist as a man with an X-ray vision, who sees more facts than he does, or as a man with a butterfly net, who collects pretty facts for their own sake. The story that I have told shows that this picture is false because its perspective is wrong.

Newton and Einstein did not in the first place discover new facts about the sun. They proposed new relations between the earth and the sun which now have for us the force of facts. Newton did not prove that the sun holds the earth in its orbit—no-one can prove that, because it is not a fact which is susceptible to test. We cannot prove such statements, any more than we can prove that a man stops thinking when we cut off his head. Newton showed that the movement of the earth and the sun round one another is most cogently explained if we assume that the sun holds the earth by a gravitational pull.

Einstein did not prove that the gravitational pull of the sun moves at the speed of light—this also is not a fact which is susceptible to test, precisely because we cannot snatch the sun out of the sky and make it disappear. Einstein showed that we must conceive the events of the universe to be linked by signals between them, and that this conception will not allow the pull of gravitation to travel faster than the light signals.

Even Römer, whose discovery looks so matter-of-fact, was as indirect, as speculative, as his contemporary Newton. For Römer did not in fact measure the speed of light: he showed that the movements of the moons of Jupiter appear more regular to us on earth if we assume that light takes time to get from Jupiter to the earth.

We have learnt since 1658 that the network of relations between the sun and the earth is more closely knit than we knew; in an odd way, it is both richer and simpler. At each step, our discoveries have enlarged and deepened the unity which we find in Nature. And this has been the purpose of each step: this is what Newton and Römer and Einstein were trying to do. They were finding the links which hold the solar system together, they were bringing order into the multitude of events, and they were making a unity out of experiences as different as sunrise and the fall of an apple. Certainly we have learnt more facts since 1658, but the greater knowledge that we have learnt, and that we learn year by year, is the integration of the facts: the growing unity of our experience.

III

The men who have made the great discoveries in science, men of the stature of Newton and Einstein, have not been butterfly collectors of facts. In a deep sense, no scientist is a collector of facts—at least, no scientist is a collector of facts and nothing else. In his modest way, even a minor scientist collects his facts for a purpose, and he is guided in looking for facts by that purpose. His purpose is to fit the facts together into a system. And if he is a great scientist, then his system is so coherent, so well knit, so single and inspiring to the beholder that it strikes him with the awe of a work of art. It has the sweep and the structure of a great work of architecture.

To talk of a scientific theory as a great building is, of course, a metaphor, but it is an illuminating metaphor. Science is a construction, a building made out of facts; the facts are as necessary to it as the stones are to the building. And just as the stones are not the building, so the facts alone do not make science. All the stones in the world only make a heap of stones; all the facts in the universe only make a heap of facts. It is the architecture, the way the stones are fitted together, which locks them and holds them, and which turns them into a building. So it is the way the facts are fitted together which locks and holds them and turns them into a unity—turns them into a scientific conception.

I must labour this metaphor, because it is so important; and so I will ask you to add one more to your conversations with the conjured dead. Imagine yourself therefore speaking to a man who was both a distinguished scientist (a mathematician and an astronomer) and an architect: Sir Christopher Wren. Faced with the mountain of stones which made St. Paul's, would Wren have called it a cathedral? Of course not; yet his thought turned it into a cathedral. And faced with the facts of astronomy, Wren's mind was moved by the same compulsion to find a design, a constructive thought which would order them into a system. The thought which Wren had, with others of his contemporaries, was precisely that there must be a gravitational pull from the sun to hold the earth in its orbit, and that this pull might fall off as the square of the earth's distance from the sun. So Wren and others in 1684 sent to Cambridge to ask Newton whether a pull of this kind would indeed make the earth run on an ellipse. Newton had had this thought nearly twenty years before, and had answered the question already. But it was the inquiry from Wren and his friends which persuaded Newton to write his answer down, and so prompted the most remarkable of all works of science, the *Principia*.

The same stones can be arranged in different ways, to make different buildings; and the same facts can be arranged in different ways, to make alternative and different theories. We often think that the facts speak for themselves, because we are used to our way of fitting them together: the theory of the moment somehow seems right and inevitable. But it is right and inevitable only as St. Paul's is, because a great mind has put the facts together in a form which is so convincing, so dominating and—I must use the word—so beautiful, that we cannot resist it. Newton's *Principia* in its day, and Einstein's Relativity in ours, have the same intellectual force as Christopher Wren's St. Paul's: the facts, the stones, are fitted together so boldly and yet so precisely that the whole structure commands our admiration and our assent at the same time.

IV

Many people think it outrageous and, worse, meaningless to say that anything in science can be beautiful. Science can be true, they say, but how can it be beautiful? And the implication of their question is that, by its nature, what is true cannot be beautiful. This is not at all how great scientists have felt about their discoveries. When they have seen how the facts of Nature fit together, they have had an astonished sense of mystery and of humility. And it is the harmony of the smallest numerical detail in the universe which has given them this sense. When the truth is as strange as this, they have said to themselves, then it is also beautiful.

Pythagoras knew that the musical notes are produced by strings of different lengths, and he thought that he recognised these lengths again in the distances of the heavenly bodies from us. Therefore he thought that the harmony of the universe is expressed in music. So it came about that Pythagoras, a mathematician, invented the music of the spheres. Two thousand years later, at the beginning of the seventeenth century, Johann Kepler discovered the laws which express the orbits of the planets, and we might think that by then such fanciful ideas would be dead. After all, the laws that Kepler discovered are our laws to-day, and they sound matter-of-fact. Yet to Kepler the numerical detail in these laws had the force of a revelation, of (to use his own phrase) the mystery of the cosmos. When he found that the same odd numerical relations hold for Mars and the earth and Venus and Saturn, he was convinced that this could not be coincidence. The numbers were too strange to be accidental; and because they were strange, they were true and beautiful together. The strangeness, the oddity persuaded him of their truth, and in the same moment gave him the catch of surprise, the astonishment of beauty. The surprise of stumbling on a relation so unexpected that it must be true cannot be separated from the emotional excitement, the sense of beauty which its unexpectedness gives us.

Rather over a hundred years ago, the planet Uranus was not keeping time. Two men, John Couch Adams and Urbain Jean Leverrier, asked themselves if it might be disturbed by an undiscovered planet, and calculated where such a planet would have to be. On the day in 1846 when Leverrier's calculation reached Berlin, the observatory turned its telescope to the part of the sky which he proposed, and at once found the new planet Neptune. The very story, the chiming of fact with theory, still makes my skin tighten in the telling—because telling it gives me that profound sense of being at one with Nature, of truly grasping her secrets, which is the living breath of science.

V

There has been a moment of exultation in my own lifetime, and I still remember it as a small boy. It was in 1919, when expeditions went out to photograph the eclipse of the sun in the spring of that year. They were testing the strange prediction of Einstein's general theory of Relativity that the light from a star will be bent when it passes near the sun. When that prediction was proved right, and the photographs showed that light is bent, my generation knew that the fine detail of truth has the precise finality of a key that slips into a lock—or better, of a keystone that closes an arch.

A scientific theory builds the facts from which it begins into a coherent structure. In the structure there are holes—what I have just called keyholes or missing stones. If the theory is right, then there should exist undiscovered facts which precisely fit into these places. We look for them, as the Berlin observatory looked in 1846 or the expeditions to the eclipse in 1919. We know what we ought to find there, what ought to be true, if the whole structure is right. And when we find that the fact is as we expected it, that the key slips into place or the stone fits plumb and snug, at that moment we feel that we are at one with the process of Nature.

The search for truth is more subtle and more personal than we suppose. It is not merely the finding of a fact: it is finding that the fact fits into the structure, and fits it right. When Kepler saw that the numbers fitted, they spoke to him as directly as the right words speak to a poet and the right forms to a painter. All at once, the fitting of a number or a fact into place has the emotional force of putting the right spot of colour on a canvas, of writing the right line in a poem or putting the right note into a piece of music. The man who does any one of these knows what John Keats meant when he said that beauty is truth.

When we see the work of a great scientist, we see a structure of logical relations as delicately linked as a building. The structure is beautiful as a building is beautiful, because its parts are so finely keyed into the whole design. We feel that the world is beautiful because it is held together by these relations. And we feel that truth is beautiful because it is the discovery of these relations—because, in the discovery, we feel ourselves entering into the mystery of the world and becoming one with it. The search for truth gives us two satisfactions, which I tried to communicate in my opening fable. One is the sense of wonder at the world: how finely knit the world is, we say, how beautiful. The other is the sense of identity with the world: how wonderful to become part of it by understanding it.

VI

The civilisation that we live in now takes its direction from the search for truth. This is what makes our civilisation different from the civilisation of the year 1000 in Europe, or from the civilisation of the Incas in South America. Every civilisation has its own values, complex and difficult to analyse and even to name; and in each civilisation, these values derive from some central activity which is important to it. Ever since the Renaissance, the dominant activity in our civilisation has been the activity of discovering the truth. The values of our civilisation for five hundred years now are expressions of the overriding importance which we give to finding out what is true.

My examples have been drawn from science, and science is indeed a characteristic expression of our civilisation. But the wish to know the truth goes deeper, through and through our civilisation. We bring back the test of everything that we believe and do to whether it is true in fact: this is the unspoken assumption by which we judge everything. We do not admit to beliefs which do not fit the facts.

When people in our society behave in ways which disregard the facts, we put them into asylums. But there are civilisations which do nothing of the kind; I had to work in one in Japan in 1945. At that time, I was trying to find out how many people were killed by the atomic bombs there. I knew that this would be difficult, as every census of the dead is difficult—because those who died have gone, and so have many other people who have not died. What I did not know was how difficult any inquiry about facts is in a civilisation so different from ours as the Japanese.

I would begin by asking a block warden a simple question: "How many people lived in your block?" The block warden would bow and say, "Many." "Very many?" I would say; and he would bow and say, "Very many." "More than a hundred?" I would say; and he would say, "More than a hundred." "Perhaps a hundred and fifty?" I would say—but there is no point in going on.

Questions of this kind led nowhere except to whatever number I was foolish enough to propose: if I ever said 123, then the block warden would bow gravely and say, with evident pleasure, 123. If I had suggested to him that the speed of light is 123 miles per second (or per century), he would have bowed and said, with equal pleasure, "Yes, 123."

The Japanese block warden was not a liar in our sense: he was not trying to deceive me. He was following the dictates of a civilisation in which respect for others has a higher value than truth to fact. He believed, he had been brought up to believe, that it is an affront to contradict, even by implication, whatever opinion a stranger volunteers. We ourselves do the same thing, after all, whenever we talk about the weather; and to the Japanese all facts are only as important as the weather. If the block warden could have thought aloud, if he could have thought at all about a matter so deeply rooted, he would have thought personal relations to stranger more important than number in block.

There is much that is attractive about Japanese civilisation. It has a dignity which derives directly from its highest value: the respect which each man owes to each. Yet its outlook is quite unlike ours, and we cannot share it. For us, brought up in the tradition of the Renaissance, it is inconceivable that personal relations can be served by a lie. We do not believe that you can make a decent world if you say that there were 123 people in a place where in fact you know there were 400 or more. This is not a sound foundation for a society, we would say; and surely we would be right in this. If something is true, in science or in everyday life, then it is basic to our behaviour that we should freely say that it is true. Our civilisation is founded on the value of truth.

VII

To set up truth as an overriding value is to give a civilisation a special character. It assumes (and it demands) a relation of trust between man and man, a total confidence in the word of our neighbour. If truth is our basic value, then we must be able to rely on truthfulness in those with whom we live. For it is impossible for any one of us to test for himself the truth of everything that he learns: so that, if it really matters whether what he learns is true, he must be able to accept the word of others.

For example, I have been discussing the relation of the sun to the earth, and have said that it takes light rather more than eight minutes to travel the distance between them. Light travels at over 186,000 miles a second, or so I tell you—and so someone else told me. Not a dozen men in the country are going to measure the speed of light for themselves. Yet we believe what these men say in the learned journals, we use its remote implications when we need to, and at bottom we test the truth of what they say only by these implications: only because the whole structure of science makes sense.

We live in a society which is held together by our confidence in the facts which we tell one another. This is the basis of our education, and it is the foundation of our form of society. By contrast, teachers under Hitler were willing to tell their pupils that the skulls of negroes are more ape-like than the skulls of Germans. No doubt some teachers believed this: at least, they accepted the authority of others for it. But it is not true. It is false, and those who said it with authority knew that, by scientific standards, it is false. Had they been taxed with the lie, those in authority under Hitler would merely have mocked at scientific standards; they might have quoted *Mein Kampf* on the value of a thumping lie. They would have said (and they did say) that the basic value in their society was something else —nationalism, or authority, or glory—and that truth mattered only if it served this something else.

The society which is willing to sustain itself by lies is at once distorted. The first lie sets it awry, and whatever is built on that makes a crooked structure, a Leaning Tower of Pisa. Once a single stone has been placed falsely, there is no longer a sense of what is upright. Men no longer have a common standard, which they can trust equally in large and in small matters.

Truth is the only sound foundation of a democratic society, because only truth provides an equal standard for everyone. Of course there remain some topics, even in our civilisation, in which we do not wholly trust the word of others—in family relations, for example, in love and often in business and politics. Yet, in almost every other field, we can take one another's word, and can listen to one another in the confidence that what we hear is as real an experience as what we see.

VIII

Education only makes sense if we can believe what we are told, and this at once makes education a joint undertaking between the teacher and the taught. Not long ago I passed the bedroom which my youngest daughters share, and I heard the eight-year-old saying to the three-year-old, "No, you can't ever see an atom—it's much too small." This bold statement happens to be true, but I do not report it for that reason. I report it because it is characteristic of the process of education. All education is a serious conversation about something important between two children—by which I mean, between two people one of whom knows a little (but only a little) more than the other, and both of whom are dwarfed by their subject.

Education is not the handing down of information from an authority who knows to a docile class of students who do not know. Rather it is part of the inheritance which one generation passes to another—the only part of our inheritance which we do not have at birth. In the biological sense, education is an acquired ability and cannot be passed on biologically—just as an animal which is taken into a hot climate and learns to live there cannot pass on its acquired ability to its offspring. But a man who is put into a hot climate does pass on his ability to live there, by speaking and writing about the things he has learnt to do to keep cool. This is the heritage of education, and it is passed on because we all have a part in it—because those who receive it add to it, change it, and make it their own. Education is a communal process.

Science is a part of this communal process, but it is not the most important part. What is important is that in this process we must, and we can, trust one another. The fact that science has been so successful technically, so that we know how to make motor-cars and medicines and weather forecasts and electron microscopes and Hi Fi records—all this is a by-product of the confidence with which scientists build on one another's work. But it is not an accident; it shows us how powerfully we can move in fields where we can trust one another's word.

We have come so far and so fast in physics, in biology, and in the techniques which derive from them, because those who have worked in them have not had to start from scratch again and again. They have been able to trust their education and to enlarge it, without spending their time in testing every experiment which someone else has already done. The research worker may think another worker old-fashioned, or stupid, or even vain; but he must not think him dishonest. He must feel that the other man will never tell even the smallest lie, and even for the most laudable good. In short, he must be confident that his colleagues, like himself, do not distinguish between means and ends (2). They say what they believe to be true, and this is the only good which they acknowledge—that truth must be pursued into the detail, and must be told in every detail. This is how the poet William Blake described the morality of a truth-seeking society:

> He who would do good to another must do it in Minute Particulars:
> General Good is the plea of the scoundrel, hypocrite & flatterer.

IX

I began with a fable about the sun, and now I have reached the moral problem of means and ends. Yet I believe that the steps that I have taken are natural and important. It is important to see from the beginning that truth is what my fable implied, a structure which knits the facts into a coherent whole. The facts may be scientific and rather dull, but the architectural structure into which a great mind organises them is as beautiful as any work of art, and for the same two reasons. In its presence we feel a sense of wonder at the world: how profoundly related its parts are. And we feel a sense of identity with the world: we feel that we have entered into it by understanding it.

A work of art, a fine building for example, impresses us in its sweep and in its detail together: we feel the design of the whole even in its small elegances. So a scientific theory reaches into the smallest of its facts, and the most exhilarating moments of discovery are those in which a new fact slips into its place like a keystone. The test of the theory is in the facts, and this test is critical exactly because a theory is more than a string of facts—because the facts must fit and lock into their places.

The test of truth is the profound basis of our civilisation. No theory, no belief, no democratic society can survive if it does not accept this test in detail, in every fact. And again, this is not because our beliefs are a string of facts: it is precisely because our beliefs are larger and bolder that they must be anchored and hinged on the facts.

There are civilisations which do not accept truth as their overriding value: they try to hold men together by some other loyalty. But in an equal society, there is no cement that can take the place of trust between man and man. The basis of all trust is a common standard, a value which all share and by which all can be measured. Truth is this value in our civilisation.

Truth cannot be reached by any one of us alone. The search for truth is a communal undertaking, in which we must rely on others and have them rely on us. This is the meaning of education, that we can be confident of what we learn and yet not accept it as the authoritative end of all learning. In this sense, education is both a means

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and an end. And a truth-seeking society does not distinguish between means and ends. It demands from each of us a devotion to what is true in the most minute particular. Honesty is the breath of science and of education, but it is also the breath of art and poetry and every part of our civilisation. Honesty is the personality of our civilisation; as people and as a civilisation, we will survive or fail by this test.

REFERENCES

1. This article contains the substance of the second Annual Institute of Education Lecture, delivered on 16th October 1958.
2. For a fuller discussion of this topic, and of other values which derive from truth, see Bronowski, J., *Science and Human Values* (Messner, New York, 1958).

THE GRAMMAR SCHOOLS AND THE FUTURE

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I. The Challenge

To discuss the future of grammar schools to-day is like sitting down in a palace to write about the monarchy while a revolution rages outside. For the first question which confronts us is whether or not the grammar school as we know it has a future at all. But whatever form secondary education may take in the years to come, the aims and methods of the grammar school will continue to have significance. Those aims and methods cannot be grafted upon the modern, bilateral or multilateral stem without a good deal of modification. Indeed, they are already being modified in the grammar schools themselves and, as I shall suggest later, the process could be carried further with advantage. But I believe that the essential core of grammar school education must continue to survive and that its spirit can breathe a healthy life into any educational system.

Before trying to define that spirit, however, it would be unrealistic to evade the challenge which the grammar schools are facing, not only to their traditional methods but to their very existence. In such a situation men are apt to rely on any defence, whether valid or not, which offers prospects of repelling the challenger. First, let me dispose of one or two defensive arguments which are not valid.

One is that the future of schools can and ought to be decided on "purely educational grounds". None of us in the schools in fact applies this criterion strictly. We all recognise, explicitly or implicitly, that education dare not ignore the needs and pressures of contemporary society. We may believe, for instance, that the study of Greek is a better intellectual discipline than the study of some branch of technology, but only the most unrepentant diehard would try to give Greek the priority in our educational system to-day. In other words, we recognise the claims of social and economic considerations in framing our educational policy. That is not to say that we are prepared to sell our educational souls without getting the best bargain that we can. We must accept that it is an essential part of our duty to prepare our pupils for the demands of mid-twentieth-century society, while insisting that this preparation must be truly educational; it must not be limited to the acquisition of technical expertise.

As machines become every day more powerful and more pervasive in their influence on our lives, some people talk as if the only important problem is how to train enough boys to master their technical complexities. But technology is a means, not an end. An education which is merely technological would bring increased mastery of the means but no clearer vision of the end to which it should be directed. Mankind would be like the crew of an immensely powerful and efficient space-ship hurtling along in total darkness towards an unknown destination. As man's power both to confer good and to inflict harm increases to an extent undreamt of in past ages, it becomes more important than ever before that those who wield this tremendous power should know what they are doing and whither they—and we—are going. The appreciation of literature, art and music, the study of human behaviour in other times and countries as well as in our own, the ability to think philosophically about the larger pattern to which our own activities contribute a tiny but maybe significant strand, the realisation of our moral potentialities and duties, have all assumed a new urgency. No-one put this better than a poet who is not very fashionable these days, James Elroy Flecker:

> I care not if you bridge the seas,
>   Or ride secure the cruel sky,
> Or build consummate palaces
>   Of metal or of masonry.
>
> But have you wine and music still,
>   And statues and a bright-eyed love,
> And foolish thoughts of good and ill,
>   And prayers to them who sit above?

Flecker was addressing "a Poet a Thousand Years Hence", but his lines have gained an added force in the forty years since he wrote them.

2. THE GRAMMAR SCHOOL AND PARTY POLITICS

Even those who admit the need to consider the social and economic claims of society are apt to shy at the word "political", as if there were something sinister in a political party having its own educational policy and seeking to put it into effect. But considering the large (if still inadequate) amount of public money spent on education and its vital role in the national life, a party has not merely the right but the duty to take thought how that money should be spent and what that role should be. Furthermore, it is entirely natural that its educational programme should fit in with its whole basic philosophy. It would indeed be foolish to expect a party to devote its political, social, economic and financial policies to the creation, or the preservation, of a particular type of society, whilst at the same time fostering an educational system calculated to bring those policies to naught.

In fact, both the major political parties in this country have educational policies which *do* fit in with their general aims. If it is the Labour Party which is more often accused of "bringing politics into education", that is merely because it is the one which wants to change things. We all tend to be conservative about our own jobs, whatever political label we may otherwise wear, and so a party which advocates a large measure of change must always reckon with the hostility of the embattled experts who run the existing system. This applies to all institutions, not just to schools and universities. It is sobering to look back at the struggles for reform in many aspects of our national life and to reflect that in those struggles most of the acknowledged experts were on the wrong side. The law was humanised in spite of the judges, the church reformed in spite of the bishops, the army mechanised in spite of the generals. We do not want future generations to be able to say that education was modernised in spite of the teachers.

I do not for a moment suggest that we should go to the other extreme, surrender tamely to whichever political party happens to be in control, and, assuming that any changes proposed are likely to prove beneficial, plunge blindly into the educational unknown. We are right to examine critically any party's educational programme and to insist that our voices shall be heard. We are right to demand that those who propose changes should show where and how the present system is defective and what grounds there are for thinking that the changes they advocate would provide a remedy. But I would be happier if the teaching profession as a whole were more ready to look for faults without waiting for outsiders to point them out, and to implement changes without waiting for their hands to be forced. The tragedy of so many reforms is that they are carried through by those who do not understand the true values of what they are dealing with but do realise that some change is necessary, while those who appreciate and could preserve these values remain aloof or hostile.

It is difficult to be objective when your own interests are involved, but schoolmasters should be better able than most to recognise and allow for this. If we could bring ourselves to concede that the outsider might be able, just because he stands outside, to see a broader canvas, and that his criticisms might stem from this and not necessarily from ignorance or spite, it would be a big step towards lowering the heat which surrounds so much educational debate.

It is not only we in the schools who ought to contribute to this desirable result. If some of our critics were less brash in their approach, if they took the trouble to study sympathetically what they are attacking, if they would realise that while the shortcomings of the present system are plain to see, the new deal which they advocate might, when transformed from blueprint into reality, develop equal or greater weaknesses, their ideas would be more likely to get a fair hearing. The planning of future educational advance should be a combined operation, with those inside and outside the schools playing their respective parts. It should never be allowed to develop into a battle between rival forces, engendering suspicion, malice and uncharitableness. In that event, whichever side emerged the winner, education itself would be the loser.

3. Organisation of Secondary Education

This is a lengthy preamble but, I believe, a necessary one. I pass now to a more practical discussion of the various types of secondary organisation. First there is the tripartite system, itself a comparatively recent innovation, though the grammar school part of it has a long historic tradition. In what follows, I shall be concerned mainly with that part and, in particular, with boys' grammar schools.

The achievement of the grammar schools has been a major factor in the greatness, in fact in the very survival, of this country. This is something that needs saying at the start of any discussion of their future. Pride in that achievement, and the apparent ignorance of it by many of its critics, is one of the reasons for the hostility felt by most grammar school masters towards proposals to alter the status of their schools. While the public schools continue to supply a large and, as some would say, disproportionate percentage of leaders, it is the grammar schools which have provided the solid body of literate men of capacity and integrity without whom the leaders would have been as helpless as generals without an army. The grammar schools have provided the lieutenants, the captains and the majors in the various national enterprises, and often the chiefs of staff whose work has been more important if less spectacular than that of their nominal superiors. In some fields, particularly scientific, where they have been less hampered by traditional curriculum prejudices, they have provided most of the leaders as well. They are well equipped to continue playing a valuable role in the future. With staffs which are in general of high all-round quality, with most of the abler boys in their ranks and supported by parents anxious to see their children make the best use of what they feel to be a privilege, the grammar schools have great sources of strength. They have the advantage of a tradition which, though not so grand as that of the public schools, is usually more flexible. Their social composition is certainly a much broader reflection of the national picture.

It would be foolish, however, to deny that there is another side to this. Because a particular type of school has achieved a great deal in the past, it does not necessarily follow that it is the best fitted to meet the needs of to-day, still less of to-morrow. It may be so, but the proposition is not self-evident. Tradition is a two-edged weapon. It can produce the kind of corporate pride and responsibility without which no institution can enjoy a healthy life; it can also breed a complacence which is unprogressive, smug and intolerant. Because of the prestige that it enjoys, the grammar school certainly attracts a number of pupils who have, so to say, just "come for the ride". Their parents like to feel superior to those whose children attend what they regard as schools of an inferior type. This is the sort of attitude which can do the grammar schools a great deal of harm, just as the hostility shown to public schools has been fanned by the arrogance of some of their products.

The main objection to grammar schools, however, probably stems from the supposed inequity of selection. Here the critics have a good deal of ammunition to hand. I have found that the only people completely satisfied as to the accuracy of the present methods of secondary selection are those who have never studied them in practice. Some years ago I carried out a research, very limited in scope compared with most surveys, but having the advantage, denied to the statistician, that I knew personally the boys concerned. This led me to the conclusion that between a quarter and a third of those who won grammar school places could have been replaced by those who did not, to their mutual advantage. Much depends upon the percentage of grammar school places available in different areas and at different times, but the conclusions of most wider surveys do not seem to differ substantially from mine. Something may be hoped for from improvements in selection technique, but my own experience was gained under an authority which took the trouble to make its tests as reliable and valid as possible, and which tried to take all relevant factors into account.

Whatever methods of selection may be used, there are two serious objections to the present system. The first is that boys do not fall neatly into three groups, grammar, modern and technical. This division was not the fruit of educational research. It came into existence partly by chance and partly for administrative convenience. It would indeed be an odd coincidence if human beings sorted themselves into three distinct types just to fit the pattern of organisation. In fact, they do nothing of the kind. There are a number who are plainly suited to an academic education and a much larger number who are not. There are others whose standard varies greatly from subject to subject. The linguist who is devoid of interest and ability in mathematics and the mathematician without even average linguistic competence are not uncommon individuals and may be capable of distinguished work in their own spheres. Yet by reason of their respective weaknesses, they may both find themselves excluded from a grammar school. In particular, the large part played by mathematics in most selection tests, though justifiable administratively—it is an easy subject to mark objectively—must result in the rejection each year of many children with real qualities of imagination and expression. Beethoven and Balzac, to name but two, would never have overcome that hurdle.

Secondly, the age of 10 is a ridiculously early one for estimating the future capabilities of all children. Their rate of development varies so much that some score from this and others suffer. Incidentally, it is not pedantic to insist that this examination is not the eleven-plus but the ten-plus. The phrase "eleven-plus" is now so firmly rooted in popular usage that its replacement is probably too much to hope for, but it is important to remember how misleading it is.

Although this is written from the standpoint of the grammar school, it is not irrelevant to refer to the effect of the selection tests upon primary school teaching. Primary school teachers are no more to be blamed for setting their sights upon the examination that their children will have to face than are grammar school teachers for preparing their pupils for the G.C.E. But any distortion of the primary curriculum resulting from this will eventually have its harmful effect upon the grammar school. It is odd that those who are concerned, as we all should be, with the dangers of premature and excessive specialisation, usually direct their attention to the age period 15 to 18, when the problem is already arising for the nine-year-old.

4. Alternative Methods

It is one thing to recognise the weaknesses of the eleven-plus but quite another to find a satisfactory solution. What are the alternatives? To postpone the test until 12 or 13 is certainly not the answer. Nothing could be more harmful to the intelligent child of 10 or 11 than to make him mark time for a couple of years simply in order that his secondary destination could be more accurately predicted. To reorganise and re-staff the primary schools so that they could cope properly with the demands of alert youngsters during this period would need an educational revolution.

Nor do I feel any confidence in the type of solution embodied in the so-called Leicestershire experiment. Indeed, of all the possible alternatives, this seems to combine the greatest number of disadvantages. The scheme, it will be recalled, provides for the establishment of "high schools", to which all pupils will transfer at the age of 11 (or, in a few cases, 10). Some will stay there for approximately four years and then leave; others, whose parents are prepared to keep them at school until at least 16, will transfer to a "grammar school" after three years. Of the many objections to this scheme, I have space only for a few. First, with no advanced work to attract them, most of the academically gifted teachers will avoid the high schools; these will therefore prove a much less stimulating environment for the abler children than the comprehensive school at its worst. Then nothing could be more likely to encourage early leaving than the need, if an advanced course is to be followed, to transfer to another school just at the age when the stirrings of independence and the attractions of high juvenile wages combine to tempt the boy or girl towards the adult world. Those ties of loyalty, of companionship, of habit (if you like) which tend to keep a boy at his school will have been wantonly thrown away. All teachers know how teenagers hate to change schools and the lengths to which some of them will go to avoid having to so do. But while able children who ought to go on to the grammar schools will leave, others of low ability will stay on because their parents wish it. Thus talents will be wasted, the standard of these new grammar schools lowered, and the "snob" element in grammar school education strengthened. The effect upon the high schools of the premature departure, after three years, of many of the better boys will be equally harmful. They will lose their natural heads, just as the grammar schools will be deprived of much of the rank and file. We shall be left with mere headless and bodiless abortions.

Some pin their faith to easier and more frequent transfer between different types of secondary school. This, for the reasons given above, is unpopular with the boys; movement in a "downward" direction would in general be strongly opposed by the grammar school parents, while much movement in an "upward" direction would be naturally disliked by modern school staffs. This may serve to remedy mistakes in a few outstanding cases, but it is unlikely to do more than touch the fringe of the problem.

Bilateral schools have been established and are working well in some areas, but they do not really meet the main objections to the present system. If the answer lies in the field of organisation at all, then some type of comprehensive school is the only expedient worth serious consideration. It is not possible to go into details here as to the difference between comprehensive and multilateral or the respective merits of organisations based on one scholastic unit or on a number. Indeed, the great variety of forms in which the comprehensive principle can be expressed and the present uncertainty as to which are the more desirable are the strongest arguments against a forcible imposition, at this stage, of a completely comprehensive system. A series of experiments is the most sensible course to adopt. Unfortunately, this plea has been somewhat debased through its use as a delaying tactic by those who are not really open to conviction at all. But an argument does not cease to be valid merely because it is not always used in good faith. It would be a reckless step to replace existing secondary schools by some type of comprehensive organisation which might later turn out to be markedly inferior to others.

For some of the doubts about comprehensive schools are held quite honestly by those who have no axe to grind and would be happy to have their doubts resolved. The bogy of size is not a mere turnip-lantern to frighten the timorous. As we see the personal touch disappear, to their detriment, from so many large organisations, whether administrative, professional or commercial, we cannot be blamed for hesitating over an educational project which seems to threaten the same result. Perhaps this result can be avoided by decentralising the organisation of the school. I am inclined to think that it could be, though I should like to be fully satisfied on the point before committing myself. Perhaps comprehensive schools do not, after all, need to be such colossi as was first assumed. Here again, some proof is needed before many of us will be ready to commit ourselves. The weaknesses of the American comprehensive school may not be a cogent argument against the comprehensive principle, because they may be due to other features of American life which do not prevail here, but at least they underline the need for caution.

I will bring this part of my article to an admittedly inconclusive end by remarking that both the supporters and the critics of grammar schools are often illogical in their attitude. If the grammar schools are such wonderful places as their admirers contend, then the latter should be much more concerned than most of them are about the number of able children who fail to gain admission. On the other hand, if the grammar schools can, as their opponents maintain, be wound up without much loss to education, why does it matter so much whether the right children get to them or not?

5. The Grammar School Curriculum

My second theme is: what beneficial changes (if any) can be made within the existing secondary framework? This theme is closely related to what has gone before. Much of the sting would be taken out of criticism of the tripartite system if it could be shown that those whom the entrance examination might misplace need not suffer for the mistake. The most important part of this lies in the modern school, in the raising of its status and, particularly, in the provision of facilities for its abler pupils to prepare for the Ordinary Level and even proceed to Advanced work. With this problem I cannot concern myself here. But there is also a grammar school side to the same problem. Just as good academic standards seem to be well within the reach of some boys who are not in grammar schools, they seem to be quite beyond the reach of some who are. There may be a number of different reasons for this. It may simply be due to the shortcomings of the selection procedure. Somehow or other, a boy has entered a grammar school who is really incapable of standing up to the level of work required. In other cases, it is plainly interest rather than ability that is lacking. This may be due to weaknesses in the boy's character or temperament or to unhelpful factors in his surroundings.

We might as well admit straight away that there will be some failures whatever curriculum and methods a school may use. But we in the grammar schools have sometimes been slow to recognise that different times and different types may need different methods from those which suited us. If a boy does not fit the traditional grammar school mould, there is a temptation to write him off as a failure and leave it at that. It is true that unless he is prepared to do a good deal of solid work in academic subjects, the grammar school is not the place for him. That is a fact which it is useless to evade or deny. A good education, like anything else that is worthwhile, cannot be acquired without much genuine effort. No amount of television sets, tape recorders, filmstrip projectors or other gadgets can alter that. As a stimulus to effort they may have real value; as a substitute for it they have none.

However, there are ways in which the traditional grammar school curriculum can be adapted, and in many schools to-day is being adapted, to suit the less academically inclined. A boy who is allowed to take, say, handicraft and technical drawing instead of Latin and French, may develop an entirely different attitude to his school work as a whole. I am perhaps old-fashioned in believing that he ought to study one foreign language long enough to see if he can acquire some interest and ability in it. But when it is quite plain that he is not doing so, there is much to be said for letting him abandon it for a more practical subject which seems, both to him and to his parents, to have more relevance to his future career. As for the study of Latin, belief that it is an essential element in grammar school education may be dying hard, but it is dying none the less and I, for one, have no wish to revive it. Latin itself would gain in repute and in effectiveness if its study were limited to those who have some aptitude for it, instead of being forced on all and sundry out of deference to past traditions.

Nor is the traditional content of the mathematical syllabus suitable for all. Much of it makes sense only for those who are going on to study some branch of advanced work, mathematics itself or physics or engineering, in which it will be needed. Many boys who are perfectly capable of understanding and enjoying parts of the syllabus are disheartened by their inability to master other aspects of it which they are never likely to need. The same consideration applies to other subjects. In history, for example, the processes of the Industrial Revolution can make an appeal to boys who are left cold by the constitutional struggles of eighteenth-century England. What enthrals Professor Namier does not necessarily interest the boy of average ability in an industrial city. He is more likely to respond to a syllabus which will help to make clear how his everyday surroundings came into being.

I am not suggesting, let me repeat, that boys who will not work hard should be allowed to choose easy subjects in which they would be able to coast along with little effort. On the contrary, my point is that the hard work which we rightly demand is more likely to be forthcoming if the subjects they study and the way in which they study them are congenial. It is, of course, true that the curriculum or syllabus reformer often comes into collision with G.C.E. regulations, university requirements and the like, to say nothing of the more prosaic but none the less cogent objections of the time-table planner. But it is also true that in teaching, as in everything else, it is easy to blame others for our own lack of initiative or courage. If teachers are clear-sighted about what changes they want to make and persistent enough to go on pressing for them in the face of initial rebuffs, even the grimmest bastion of reaction will eventually have to come to terms.

ARITHMETICAL DEVELOPMENT AT THE INFANT SCHOOL LEVEL

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1. INTRODUCTION

THIS article describes an investigation carried out with a group of thirty-seven children who entered school for the first time during the school year 1955-56. The intention was to try to discover how they progressed through their own explorations of home and school into the somewhat narrower and more formal channels of intellectual learning. Thus it was a study of children in their ordinary school environment, with no deliberate changes wrought by the investigator.

The children worked in an ordinary classroom with small tables and chairs arranged in an informal manner. Various types of material were placed on the tables, including paper and paint, plasticine, cardboard boxes for model construction, and a small library of simple picture-story books. Elsewhere available in the room were water, clay, sand, small and large wooden bricks, and a house with simple fitments for house-play. When the children entered the classroom each morning, they freely chose materials and occupied themselves with these as they wished during the first hour. The teacher moved amongst them, discussing the work in hand, thereby using this to further each child's knowledge, and giving help and advice when asked by individual children. This individual creative work formed the basis for many of the more intellectually formal activities which followed later in the day. In particular, attempts were made by the teacher to use this creative work to generate simple work in arithmetic, especially during the second and third years in school. In this article an attempt is made to describe how these children approached their arithmetical learning, and to analyse (where possible) the stages of work and the kinds of thinking involved. At best this can only be an exploratory study, since on the one hand it was only possible to make disjointed observations of the children at work, and on the other, subjective interpretation is bound to play a large part in any final analysis. In the latter case, however, it can be said that the children became so friendly after a few weeks that they talked quite freely and spontaneously about their work at all times. Hence it was possible to obtain many first-hand examples of their arithmetical thinking.

Throughout the six terms of the study, weekly observations were carried out as the children worked during the opening period of the morning (1). During the first year, detailed records were kept of all individual creative work involving pre-number or number experiences. During the second year, detailed records were kept of the work accruing from the use of one kind of material each week, and these were analysed for pre-number or number experiences. In addition, during the second and third terms of the second year, all the children were observed when engaged in more formal arithmetical work. Information regarding their attack and thinking in this kind of work was obtained by asking them to work simple sums orally, and also to work orally through sums which they had already written. As in the work of the late Dr Susan Isaacs (2), the records of the early morning creative work were written by observers within the classroom. They took no part in the work unless spontaneously consulted by the children. Thus, attempt was made to observe dispassionately the work done by the children under normal classroom conditions. In this setting, an individual child could only be influenced by the teacher or by other children of the same age. The intelligence quotients of twenty-five of the children were also obtained by the Terman-Merill revision of the Binet test. These ranged from 85 to 130+.

It is necessary to distinguish between children's pre-arithmetical experiences, arithmetical experiences, and formal arithmetical work. For present purposes, pre-arithmetical experiences may be taken as those experiences occurring spontaneously within the children's creative work which could be translated into arithmetical form; arithmetical experiences may be taken as those similar experiences into which numbers enter, i.e. which have already been made precise; formal arithmetical work is, as in the ordinary sense, the working of sums without the concrete background of experience or the use of individual materials. When the present investigation was terminated all the children concerned had passed through the first two of these stages and had reached, or were reaching, the stage of formal arithmetical work.

2. Pre-Arithmetical Experience

Observation of the children's spontaneous use of materials in the classroom showed that they had many pre-arithmetical experiences during this time. Their activity was purposeful and alert, and their thinking was forward-looking and completely orientated to whatever goal they had set themselves to achieve. These pre-arithmetical experiences formed part of much practical experience which they gained at this time, and the thought-processes involved appeared to be the same as those used in the later stage of arithmetical experiences. The children had not yet grasped the existence and purpose of the number system, and so their expressions of quantity were vague and imprecise. For their own purposes they arrived at a convenient solution, and the process of bringing them to the stage of arithmetical (or numerically precise) experiences was probably just the process of producing a willingness to accept numbers in terms of their usefulness in practical classroom situations. The pre-arithmetical experiences showed all the elements of the simple arithmetical thought-processes of addition (putting together), subtraction (taking away), multiplication (balance of equal quantities), and division (sharing into equal groups), as well as embryo fractional expressions and one-to-one correspondences.

The children's activity during this time also demonstrated a good deal of trial and error thinking as well as a more logical and sequential approach to certain sets of problems. A group of four children shared a packet of coloured paper. The actual sharing involved much trial and error argument but the result was the same as would have followed from a straightforward application of the division process. Another interesting feature was the acceptance of the "unsolvable" —a realisation that a stage has been reached at which the problem cannot be solved within the present experience of the child concerned. For example, using bricks which were all of the same shape and size, a boy aged five years and two months had built two towers, the first being one brick shorter than the second. This inequality was due to his inability to pair each side properly. He had checked by counting, but he had miscounted, and hence arrived at the same number of bricks in each tower! He had difficulty in accepting that the two towers of bricks were, in fact, not equal, but after a short time he was heard to say "Well, they ought to be," and he walked away to a new activity. Such pre-arithmetical experiences occurred for all children irrespective of intelligence, and they were often the counterpart of quite complex arithmetical work in the more formal field. The role of the teacher was all-important in helping the children to turn these pre-arithmetical experiences into arithmetical form, or to learn to use numbers to help them in their everyday activities.

There seems little doubt that number-names were learned by association with specific groupings of objects or people, and these were reinforced by continuous use until the child could pick out and name the number-groupings for himself. In the actual acquiring of knowledge of numbers, almost any learning theory of association and reinforcement would find a place in the description of the child's thinking at this stage. That it is association with characteristic groupings seems borne out by the fact that children often alluded to other similar groupings, especially in the early stages, as if seeking reinforcement for themselves. For example, a child of five years and three months said, "I've painted four daffodils—there are four children here, aren't there? and four chairs and four books—but only one table." There were many similar instances. Careful work by the teacher was needed to co-ordinate and reinforce these associations, without allowing undue delays, otherwise there was intermediate fall-off in a manner similar to that described by Hull (3) in his discussion of Gradient of Reinforcement.

Where children had been taught to count elsewhere, there was a surprising dichotomy between counting and number groups. The ritual of counting appeared to fascinate these children, and it was immaterial to them if the sequence of number-words was not the correct one. Yet when the same children performed counting in order to establish the number of objects in a given group, much more care was paid to the accuracy of the words. Counting for counting's sake appeared to lack purpose (other than perhaps the pleasing of adults), whereas counting within the framework of another activity appeared to draw purpose from the activity. For most of the children, the two aspects of counting appeared different. One was fascinating, one was utilitarian.

3. INTRODUCTION OF ARITHMETICAL EXPERIENCE

The desire to incorporate numbers into their ordinary activities was generated for an individual child by the teacher, by other children, or by agencies external to the school. Acquiring this facility to use numbers often depended on some elements of trial and error as well as on the individual's level of development. There quite evidently was a sequence of developmental stages through which a child passed from the level of pre-arithmetical experience to the level of formal arithmetical work, but within this sequence many irregularities of the trial and error type were noticed before the functional arithmetical thinking came into its own. During the transition from pre-arithmetical experience to arithmetical experience, much appeal was made to working with different kinds of material since here the meaning of the numbers was made clear. The chief stumbling-block in the transition from pre-arithmetical experience to early arithmetical experience of this kind appeared to be emotional rather than intellectual, depending chiefly on the degree of adjustment of the child to his teacher, to other surroundings, and to the school as a whole.

As further arithmetical experience proceeded, the writer's observations showed stages of development and acceptance similar to those described by Piaget (4), though with much more flexible age-ranges than he ascribes.

Four aspects of the children's thinking were found to be of particular interest. Firstly, the few children who had the degree of insight required to go further in the actual manipulation of numbers did so increasingly quickly as their intellectual experience widened. They appeared to discard the practical side of the work in their excitement over their new-found number sums. It is an arguable point as to whether such children fail to progress at a later date because they did not obtain practical number foundations at the earlier stages. From the point of view of the present investigation, it can only be said that they did not appear to lose confidence or progress in the first two years. From the writer's wider experience of older children, it would seem possible that some children do lose by too early a transition to the pattern of formal work.

Secondly, the degree of arithmetical thinking was much helped by the provision of certain materials for the children's spontaneous work. In this investigation, the brick-play and the shopping-play led to far the greatest incidence of pre-arithmetical and arithmetical experiences, other materials tending to contribute less and less as the children matured. With these findings, it is of interest to notice that both boys and girls enjoyed this wealth of arithmetical experiences, and that the most important materials for this purpose were certainly not used predominantly by the boys.

Thirdly, the structure of the children's arithmetical thinking was not confined to one-step reasoning, and a given piece of practical work might involve up to three different steps in the related thought-process. It was usual to find recognition of numbers and the operation of at least two of the four basic arithmetical processes within the compass of any one piece of practical experiment. The young child does not produce the stark clarity of the arithmetical version: that form of precision is for a later date. But the child's apparent thought-process follows closely on the lines of its more formal counterpart.

Fourthly, the thinking did not always follow one line only, but transitions were made to new lines when circumstances warranted. Such sequences of thinking were generated by the uses and possibilities of the available materials, as well as by the initiative, intelligence and insight of the individual and his companions. Thus the scope and number of the different lines of approach do vary with both child and circumstances. This fourth characteristic of the children's thinking conforms exactly with Stage 3 of Problem Solving as described by Duncker (5).

4. The Transition to Formal Number Work

The transition from arithmetical experiences to formal number work is a highly complex process which tends to take place without being consciously expressed. The writer's observations suggest that there is a continuum from the early pre-arithmetical experiences, through the arithmetical experiences and on to the more formal number work. Spearman (6) and Isaacs (7) have both specified this kind of continuity. Furthermore, it is clear that the rate of transition between these stages varies considerably from child to child. During the period of observation two of the children only just passed through the first two stages. The others passed on to the second and third stages at very different times and in very different ways. There are pointers that some of these differences may be due to differences in background experience, and equally that some of the rapid progress is associated with higher intelligence.

That the transition does take place is clear. Occasional pointers as to how it takes place have shown themselves. A boy of six years and one month was watching his teacher, who was planting bulbs in twos. He said: "Two ones—that's two; two twos, that's four." Then he continued: "Two threes would be six; two fours would be eight; two fives would be ten; two sixes would be twelve, wouldn't they?" When asked if he was sure, he replied: "Yes, it would be the same with books or chairs or children."

Similar evidence of this kind of transition was obtained when some children looked for apparatus to help them with their formal work. This use of apparatus appears itself to be a transition in the understanding and acceptance of numbers and number combinations, and not a development in the type of thinking involved. The structure of the thinking is of the same basic nature at each of the three stages of development—it is the precision of the actual number concepts which gradually develops. The changes in thinking appear to be concerned solely with increases in the complexity of reasoning (usually in the number of steps required), and these increases can show at any of the three stages described above.

Much of the discussion of categorising and concepts by Bruner (8) and others would appear to be relevant here, and could be fitted externally on to the observations—more especially the sections on concept formation and attainment, and on selection and reception strategies. This work is also akin to that described in the more mathematical terms of classification, ordering and seeking out of correspondences by Hamley (9) in his book on mathematical thinking, and by Russell (10), on the side of mathematical logic.

5. FORMAL NUMBER WORK

Turning now for a moment to the children's thinking in their formal number work, one may first observe that this work is not completely teacher-orientated, and can be creative and original in its own right. For the children observed in this investigation, all the small formal types of sum had been discussed with them at one time or another, mostly arising from the necessity to record numbers in the course of their arithmetical experiences. Observation of their actual working methods for any one type of sum showed a number of different approaches. They did not necessarily follow the teacher's method. In fact, a number of them used their own methods successfully and happily. There were, for example, six methods of attack for a simple addition sum, ranging from rewriting the sum as tens and units separately to counting straight through all the numbers (and finishing up with the right answer!). There was sometimes considerable discussion amongst the children as to the correctness or otherwise of their own methods and that of the teacher, and it was not unusual for a child to express his sum in more concrete form (progressing back to the second stage of arithmetical experience), in order to prove his point.

There was real arithmetical thinking in this class of children, and not merely the following of an anticipated teacher pattern. This can be contrasted with observations made over a period of one year in a purely formal school, where arithmetic consisted entirely of formal and routine presentations, and where the method of working a particular sum was the same for all children, completely teacher-orientated, completely arid and lifeless for the children, and leading to a uniform pattern of work irrespective of individual differences in thinking. Arithmetic is not a hard and inflexible system of numerical patterns: it is an integral portion of the field of human knowledge.

In a final test carried out by the writer, thinking in the formal work tended to be both forward and backward in the number development sense. The quicker children worked through the sums with a forward-looking tendency, and they sometimes consciously anticipated the next step until the sum was complete. About 50% of the children asked if they might use, as concrete aids in counting, a pile of books or some pencils near at hand. These children appeared to be looking backwards, for assurance, to their past stage of arithmetical experience.

One further aspect of thinking which should be mentioned is that which might be called "group thinking". During the spontaneous activity period, the children frequently worked in self-chosen groups. Here there were some good examples of joint arithmetical thinking in which each member supplied one stage, and in which each member helped to stimulate the thought of the whole group. In this way the contributions of the individual members combined to form a continuous piece of thinking, and everyone, including lookers-on, gained something from it. Analysis of situations of this kind, along with the corresponding sociometric patterns in the group, may well provide a future contribution to the establishment of thinking and learning patterns in the classroom and elsewhere.

6. Conclusion

Given the opportunity, arithmetical work has a major part to play in the creative education of primary school children, arising, as it does, in both individual and group interests. Its development under the kind of circumstances described in this article can and does lead on to a secure and well-established basis for later formal work. Such development largely depends on two major factors which are in danger of being overlooked. Of the utmost importance from the teacher's point of view is the recognition of arithmetic as a subject which plays an active part in the description of the children's everyday experiences, and which represents the numerical means of recording and offering precision to experiences of the quantitative kind. Later this subject leads on into mathematics, and it is here that the best method or the unique process comes into its own.

The fascination of the formal number patterns must be built on the basis of good friendship with numbers and sound, common-sense understanding of their use. Arithmetic is not a subject born and bred in a formal strait-jacket. It is a product of the human mind and a partner in human development. It has not one form, but many, all leading eventually to the number system which is the backbone of all mathematical work.

Of equal importance from the children's point of view is the building of the bridge between their common-sense and readily accepted use of numbers in ordinary affairs, and the later formal arithmetical work. Ordinary living is bound to bring the former into proper perspective, whereas the latter lacks meaning and frequently becomes shrouded in the dull clothes of repetition and despair. That the bright primary school child accomplishes his formal work well is neither guarantee for his future nor admonishment for his less intellectual contemporaries. A flair for number may acquire him temporary success and, up to a point, he will learn by intuition and rote. But if his foundations are poor, he may have difficulty in developing his mathematical knowledge at a later stage. Progress in arithmetic and mathematics depends on understanding, acceptance and mastery at every stage.

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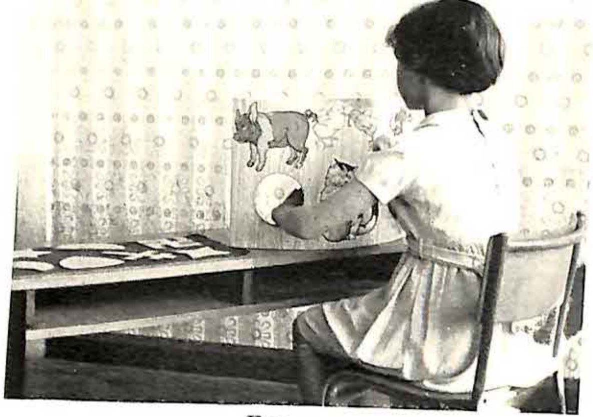

FIG. 1

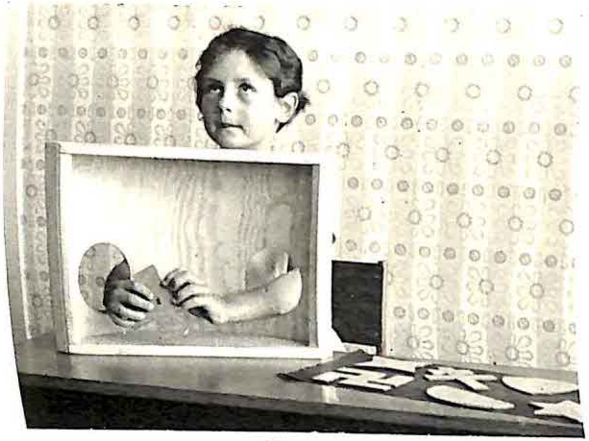

FIG. 2

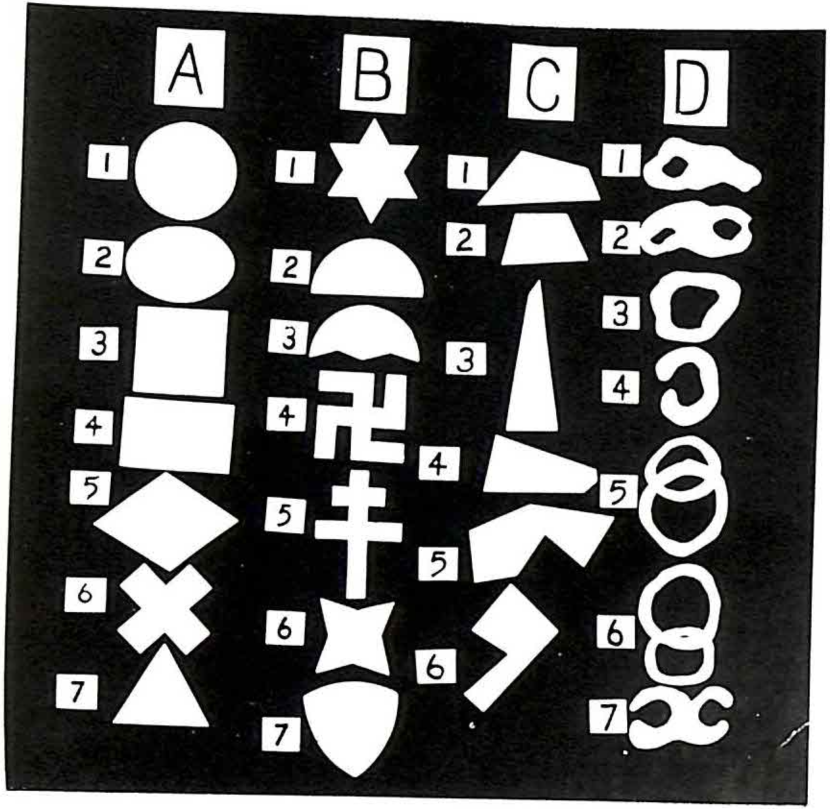

FIG. 3

HAPTIC PERCEPTION

A CONSIDERATION OF ONE OF THE INVESTIGATIONS OF PIAGET AND INHELDER

by ERIC I. PAGE
Assistant Master, King's Norton Primary School

I. INTRODUCTION

THE increasing interest shown in the work of Jean Piaget has led many teachers and others concerned with the education of children to wish to see his experiments repeated with children of comparable ages in this country. Desirable though this may be, the vast range and scope of Piaget's work make it a formidable task, and one that must be attempted in a piecemeal manner. Furthermore, not least among the difficulties is the matter of deciding where to begin. Here one must consider the general underlying theory upon which Piaget's work is based: that the mental growth of children proceeds by ascertainable stages which may be related to the age of the children concerned. Also, given a reasonably large and representative sample of children, testing with tasks entailing the exercise of the fundamental skills of concept formation will show the progression of these stages.

With these considerations in mind, it was decided to repeat the experiment reported by Piaget and Inhelder under the title "Haptic Perception" (1). The result is reported here in the hope that it may be of use and interest to those concerned with the education of young children.

The original investigation may be outlined in Piaget and Inhelder's own words. They write as follows:

> The child is placed before a screen behind which it feels the objects handed to it. The following objects are offered in succession:
> 1. For very young children a series of common objects.
> 2. A series of cut-outs in the shape of geometrical figures:
>   - A. Simple and symmetrical,
>   - B. More complex, but symmetrical,
>   - C. Asymmetrical, but with straight sides,
>   - D. A number of purely topological forms.
>
> When the child has named the objects it has felt it is asked to identify them among a collection of figures, or draw the figure felt.

2. THE TWO EXPERIMENTS

As Piaget and Inhelder do not set out precise details of the apparatus used and the conditions of testing, it was not possible to ensure that identical tests were given this time, although the original experiments were followed as closely as possible. However, unlike the original investigation, where apparatus seems to have been varied from one child to another, in this series of tests the range of apparatus was limited, and the conditions for each child were identical, except that where further testing would clearly lead to negative results it was not pursued.

Altogether sixty children were tested, ranging in age from two years and ten months to seven years and nine months. They were asked to sit before a curved screen. The hands were put through holes cut in the screen, and the forms were felt out of sight of the child, but otherwise in view (Figs. 1 and 2). The younger children identified the forms by selecting, from a set of forms displayed in view, a form thought to be like the one handled; the older children were asked to draw the form felt. Some children were asked to do both, but on different occasions. The objects and forms were (Fig. 3):

1. A set of familiar common objects—a spoon, a comb, a pencil, a cotton reel, a small hard ball, and a key.
2.
    - A. Seven simple Euclidean geometrical shapes.
    - B. Seven similar, but more difficult, shapes.
    - C. Six geometrical, but asymetrical, shapes.
    - D. Seven topological shapes.

3. RESULTS: STAGES OF DEVELOPMENT

Piaget and Inhelder arrived at the temporal divisions shown below. With very slight modification these are used in the following summary and comparison of the results of both investigations (2).

Stage I. Up to 3-6 or 4-0 years:
  Substage IA—2-6 to 3-6 years and
  Substage IB—3-6 to 4-0 years.
Stage II. From 4-6 to 6-0 or 7-0 years:
  Substage IIA—4-6 to 5-0 or 5-6 years.
  Substage IIB—5-0 to 5-6 years.
Stage III. Above 6-6 or 7-0 years:

(a) *Stage I: Up to* 3-6 *or* 4-0 *years*

The tests were given to 14 children falling into this group. There were altogether 98 presentations of the simple Euclidean shapes (the

"A" set, Fig. 3) and there were in all only 16 correct responses. One must compare this with 77 correct responses to 84 presentations of the familiar common objects. This difference is emphasised because it indicates that the failure was caused by the difficulties inherent in the forms, not by any inability to work with the apparatus. Even more interesting, out of 98 presentations of the topological forms (the "D" set, Fig. 3) there were 45 correct responses. This accords with Piaget and Inhelder's finding that at this age familiar objects are more or less easily recognised under haptic conditions, but not geometrical figures; and that (speaking of the later part of this stage) the shapes first recognised are not Euclidean but topological. According to Piaget and Inhelder, curvilinear and rectilinear forms are not distinguished by children of this age. However, it was not found that the children tested confused these types of forms to any great extent.

(*b*) *Stage II: From* 4-6 *to* 6 *or* 7 *Years*

The first subdivision of this stage is in fact the gap which lies between the end of Stage I and Substage IIA. It covers the period from 4-0 to 4-6 years. Of this period Piaget and Inhelder remark upon "crude differentiation of curvilinear from rectilinear shapes" and say that "such shapes are not differentiated among themselves". The children tested in the present experiment had much more competence in this matter than these remarks might lead one to expect. However, our results supported the observation that representation by drawing was now possible, though in respect of accuracy lagging behind identification by choice.

During Substage IIA, which covers the period 4-6 to 5-0 or 5-6 years, children, according to Piaget and Inhelder, are able progressively to differentiate shapes according to their angles, and even according to their dimensions. Drawing, they remark, becomes more precise, and tactile-kinaesthetic exploration shows signs of a search for significant clues to identity. With the reservation that these characteristics were in some cases exhibited by children younger than 4-6 years, one must agree that the observations are generally applicable to the children we tested in this age range.

Substage IIB overlaps the end of Substage IIA. According to Piaget and Inhelder it is during this stage that the differentiation of cross and star forms begins, and that the rhombus and trapezium are discovered, but many errors still occur in the representation of complex forms. Again, we found general support for these conclusions.

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The cross and star forms gave particularly interesting results. It was noticeable that though cross and star forms were perhaps distinguished by selection, they were often drawn in identical fashion. One of two forms would usually be adopted, one being basically a cross form, and the other basically a star form. The star form is a shape having a number of arms radiating from a common centre, which may be a point or may have dimensions, the arms being either pointed or consisting of simple strokes. The cross form, on the other hand, is more blocked in shape, the arms being blunt or slightly rounded at the extremities. Fig. 4 represents the cross form and Fig. 5 the star form. These are reproduced from the drawings of a boy of 6-0 years and represent respectively the forms B5 and B6. It will be seen that here the child is using the basic form to distinguish between cross and star, although he describes them both as flower heads. The same descriptions are often given to both forms, especially when the two types of shape are not distinguished from each other. The swastika and the Cross of Lorraine are often included in either the cross or the star category.

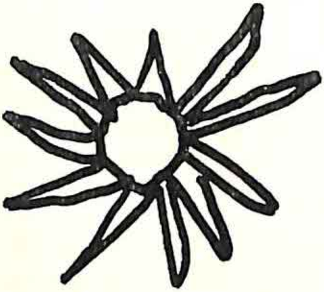

Fig. 4

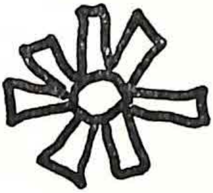

Fig. 5

(*c*) *Stage III: Above* 6-6 *or* 7 *Years*

This stage, commencing as it does at 6-6 or 7-0 years, leaves a gap between itself and the conclusion of the last substage. Stage III is said by Piaget and Inhelder to be noteworthy for methodical explorations; also, drawing and powers of recognition show exact correlation. Again, the results of the present experiment were in general agreement with these observations. It was with a girl of 7-1 that we first saw signs of an approach that might be termed "operational", and it was generally apparent that the operational level was being reached during these months. There was active and purposeful search for symmetry and balance, and this was shown at both the perceptual and the representational level. The exploration of the forms became much less haphazard, and had every appearance of being under the active control of intelligence. Of course, use was still made of "chance" discoveries, but there was also anticipation in the handling. If one hand was found, the other was looked for. Incidentally, this might to some extent account for the difficulty found with the asymmetrical forms, which throughout the testing were those done with the least success.

This is not to say that an approach which could be termed operational was never detected earlier. Indeed there is some evidence which appeared to show that children younger than those in Stage III might make an operational approach to a simpler form, yet revert to a less advanced method when given a more complex form to feel.

The general conclusion was that the stages outlined by Piaget and Inhelder were reproduced in the present experiments; and despite some differences in ability at certain ages (among the younger children, who seemed to be somewhat in advance of Piaget and Inhelder's scale), the similarities are so great as to be, in the opinion of the writer, conclusive.

4. RESULTS: RECOGNITION OF TOPOLOGICAL AND EUCLIDEAN FORMS

It has already been said that the topological forms were recognised with greater facility; this was particularly noticeable with the younger children tested. One of the most curious facts noted by Piaget and Inhelder, and found again in the present investigation, was that topological forms are recognised at an earlier stage than are even simple geometrical forms of a Euclidean nature. The natural response of an adult looking at the forms is to regard the topological forms as being rather more complicated, and the simple Euclidean forms as being easier. Nevertheless, the children between 2-5 and 4-0 years were nearly three times as successful with the topological forms as with the simple geometrical shapes. This greater facility was, in fact, observed throughout the entire range; although, as might be expected, the gap narrows with the older children.

Possibly it is the fact of the "primacy of topology" that is important, and speculations as to possible reasons for it may be of no more than academic interest. Nevertheless, one could perhaps postulate that the facility with which topological forms are recognised suggests that their qualities are identified by movements concerned with images retained by neuro-muscular combinations in areas or levels more primitive than those concerned with the abstractions of

Euclidean forms. Straight lines (and therefore angles), circles, and derivative forms do not occur in nature in any form the recognition of which is essential to a primitive existence. On the other hand there can be no doubt that topological qualities such as closure, separation, proximity, and continuity are important, and that action depends upon judgment of them if it is to be successful. It can be inferred from this that the ability to abstract logical similarities and differences, and to synthesise the abstractions seen in Euclidean geometrical forms is a later development; and possibly the development of this second ability depends upon the attainment of the first.

In the present investigation the greater facility shown by children in identifying topological shapes came early to notice. The following cases are illustrative of this:

(i) *A boy of* 2 *years* 10 *months*. This boy did not altogether succeed with the familiar common objects, but he scored three successes with the topological shapes. In the case of D1 he was asked if it could be D2. He was quite sure it could not. When he was tested with the "A" set he was unable to identify any of them under haptic conditions, and was only partly successful when asked to place them on the array models by simple visual superimposition.

(ii) *A girl of* 3 *years* 5 *months*. This girl was in obvious confusion over the "A" set. She showed the beginnings of an ability to distinguish the curvilinear from the rectilinear shapes, but was not able to distinguish them among themselves. However, she scored five successes with the topological forms.

These cases were quite typical of the younger children, and it was apparent that the topological qualities were those which influenced the children's perception at all ages. The qualities of openness and closure were especially important; and in drawing very rarely was an open form closed, or a closed form left open. Indeed, the determined efforts made by several of the children to have these matters right, and the prodigies of muscular control exhibited in the effort to make two lines meet, or not meet, were fascinating to watch.

5. RESULTS: THE DEVELOPMENT OF EXPLORATORY HANDLING

In the course of the testing it soon became apparent that success in either identification or reproduction of the forms was closely related to the type of exploratory handling exhibited by the child being tested. It is certainly the case that tactile-kinaesthetic exploration passes through definite stages, and presumably the type of exploration is related to the mental image formed. The movement on the forms is essential, and without it there is little or no success. There are really four stages of exploration, although the first hardly qualifies for the description. They are:

(i) No movement at all. The object is simply grasped, as one might hold a book (Fig. 6). This was common with the very young children, and it led to little success. It seems to be what Révész termed the "static tactile process" (3). The child may make a correct identification if, as though by chance, the finger passes through a hole, or the palm of the hand touches a point. Why children do not make the movement they clearly might make, and indeed do make in normal handling of objects, is debatable, but seems to be related to their mental ability to dictate, control, and utilise the sensory impressions which would ensue.

(ii) The next type of movement is more generally met with after 4-0 years, and is shown when the model is turned slightly, rather as a car steering wheel is turned. In the beginning the movement may be slight, but in some of the later cases the model is turned round again and again. The object of this might loosely be described as "seeing what happens" rather than as making a conscious and purposeful search. The palm of the hand is used at this stage rather than the fingers. As an exploratory process it seems to stand between the passive and the dynamic stages, leading from one to the other. It is important in that movement is involved.

(iii) The next type of exploratory activity follows from this, and seems to develop at about 4-6 years. Essentially it is an attempt to discover features, coupled with a controlled tracing of the outline with the fingers. This is perhaps accompanied by such words as "a down, a long, up, another down". Though it may lead to reasonably correct identification, in reproduction features are multiplied, so that a star may become a series of chevrons running in a large circle, or simply down the page.

(iv) From the age of about 5-0 years a further type of exploration develops. Initially it consists of an attempt to discover more than one feature, and to relate these features in some manner one with another. For example, in a star shape it may take the form of touching two points with a finger and thumb (Fig. 7), or spanning across opposite internal angles (Fig. 8), or a finger and thumb may be drawn to the tip of an external angle (Fig. 9). At this stage the movements of the child are purposive, and clearly under the control of thought. In connexion with this type of exploration, it was interesting to see that stars were often drawn with the correct number of points, although it seemed unlikely that they had been counted. Eventually a boy was asked if he had counted, and he replied, "No, I just feeled." In fact, if counting had taken place, one might have seen in it a departure from a purely "this-here-now" type of thought to the radical beginnings of a search for formulae.

These stages of tactile-kinaesthetic exploration do not appear simultaneously over the whole haptic perceptual field. It was noticeable that there was a tendency to revert to a less advanced method with a more complicated form, even though a more advanced method had been successfully applied to a less complex shape.

6. RESULTS: VERBAL DESCRIPTION AND DRAWING

The last important observation arising from the work done is that the children, with very few exceptions, tried to find some meaningful association of the object being felt. (They were, of course, asked to name the familiar common objects.) It was easy to see what was meant when descriptions such as, "a ball, a star, a brick, a door, a square, an egg, a roundie, a windmill, a half-moon," were used. It is not difficult to see that D7 is like a crab, or to agree with two children who thought that B7 was like a church or church doors. Other descriptions are less easy to follow. Why, for instance, is B3 thought to be "like nipping down a tree"? The same boy thought B5 to be "like one of those things you dig in the ground and put your chest on. It goes brrp-brrp." Another child thought D4 to be a garden with a way out, and D3 to be a garden with no way out. The descriptions always seemed to influence the drawings, often to a startling extent. One girl described D1 as "a little chick" and drew it complete with legs, tail and a beak. This was not mere fancifulness. The form had strongly suggested a chick to her, and the rest had followed. She was asked to handle the form again, and try to find the legs. She did so, and failing to find them seemed confused, and said, "I thought they were there." Another girl thought C5 to be, "like a hen. I couldn't feel the legs." Her drawing depicted a remarkably good legless hen.

The above are instances in which the form was likened to a known object. Even with the term "a square" one might fairly assume that it is not an abstraction. Another type of description was attempted by some children. This consisted of some such wording as, "an up, a down, a long . . ."; or, "it goes in, and then out, and it's got a bump sort of thing. . . ." The first type of description, that is, naming the form, is related to a more precise image of the shape,

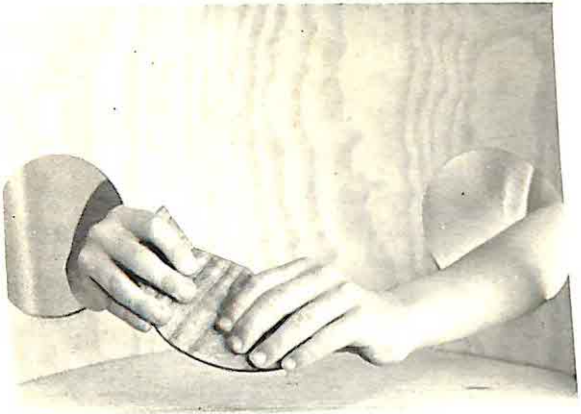

Fig. 6

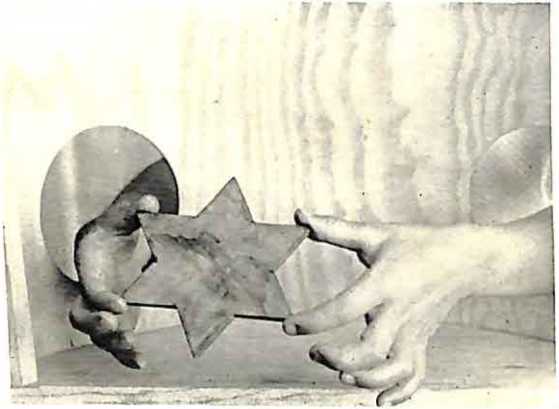

Fig. 7

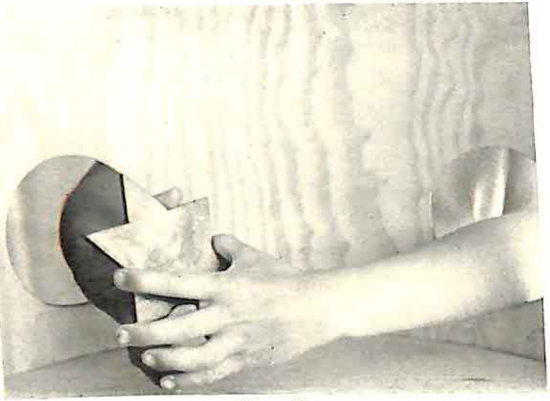

Fig. 8

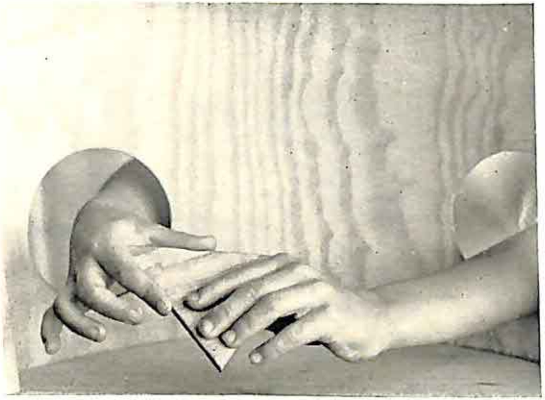

Fig. 9

however correct or incorrect such an image may be. The second type of description is much less accurate, and appears to be related to the round and round type of handling. It possibly signifies that the child is *unable* to find any meaning in the form. It was at least clear that once the object had been named the child would draw with greater confidence, and often the drawing would bear a greater resemblance to the thing named than the form itself did. For example, D2 was called at different times a pair of spectacles and a pair of boxing gloves tied together. In the first case the resemblance to spectacles was clear, and in the second the effect of a pair of boxing gloves hanging by their joined laces was pronounced.

7. CONCLUSIONS

The importance of such work as this lies in the extent to which it reveals the way in which learning processes develop, and the order in which physical qualities are apprehended. In these particular experiments the children were placed in what was practically a unique situation, for in real life they have the assistance of vision when undertaking similar tasks. It may well be that the haptic processes do in fact closely resemble in their development the much earlier growth of visual ability, although this is by no means certain. What is unlikely is that we adopt in one perceptual sphere processes which in their priority and order differ basically from those in any other sphere. Assuming this to be true, then the earlier facility shown with topological forms becomes of importance, and especially so if it were to be shown that the age at which competence in skills related to a particular stage is attained varies to a greater or lesser extent according to the general ability or intelligence of the child. If one considers the topological identity of certain letters one can see how this could have a bearing on the teaching of reading and writing.

Another open question is the possible effect of practice upon these perceptual skills. There is probably an optimum rate of progress for each child, and this is likely to vary again according to general ability and intelligence. These, however, are still matters awaiting further research. What is perhaps of greater significance in classroom practice is the variety of interpretation which children may place upon the same perceptual data; the desire to make new concepts meaningful against the background of previous knowledge even at the expense of distortion; and the apparent fact that simple Euclidean forms are not basic, almost instinctive, patterns, but are slowly built up from more primitive beginnings.

NOTES AND REFERENCES

1. Piaget, J. and Inhelder, B. *The Child's Conception of Space* (Routledge, London, 1956), pp. 17-43.
2. It will be seen that these divisions are somewhat loosely defined. In the opinion of the writer, this may be taken as an indication that they are not to be used in a hard and fast way, but as a general outline of a progressive development.
3. Révész, G., *Psychology and Art of the Blind* (Longmans, London, 1950).

IMMEDIATE AND DELAYED RECALL OF INFORMATION PRESENTED ORALLY AND VISUALLY

by W. H. KING

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THE importance of attentive and accurate listening by children and adults has never been questioned by teachers. They realise that communication must be a give and take between two people, involving speaking and listening, writing and reading, and these are the basic tools of learning. Any serious lack of proficiency in any of these skills must be a great handicap in the learning situation. Two reports from America underline the importance of listening if only because of the time expended in the classroom. Rankin (1), as far back as 1929, reported that 45% of each school day is spent in listening, 30% in speaking, 16% in reading and 9% in writing. Wilt (2), in a research reported in 1950, said that although he believed the teacher considered listening less important than reading, children are expected to spend more time in listening than in any other school activity. He found that teachers expected children to listen 57·5% of the time. There is no evidence that these figures are applicable to our own schools but they do provide a salutary shock and a very good reason for emphasising accurate recall and reporting of speech. Errors in students' notes at all educational levels do emphasise that lack of clarity in the speaker is not the only cause of misunderstanding.

Research in America has dealt with the effects of auditory and visual presentation in advertising, radio and television but there is a large number of researches dealing with basic material. As Carver (3) has pointed out printed words are "experienced more as related items in larger groupings than in isolated units". The number of words grasped by a single perceptual grouping will depend on the difficulty of the passage and the familiarity of the reader with the material. The reader progresses at his own speed, grouping the sets of words and phrases as he wishes, going back if necessary to study particular words and contents.

In listening, where the words are separated in time, the listener will have great difficulty in making his own groupings, and such groupings are more often determined by the pause and intonation of the speaker than by the free choice of the listener. Carver also makes the point that untrained minds are unable to listen intelligently to material which they could, perhaps with difficulty, understand by reading.

With training college students, Goldstein (4) reported a correlation of 0·78 between listening and reading comprehension and deduced that

(*a*) Listening comprehension is, in general, superior to reading comprehension.
(*b*) The superiority of listening comprehension is decidedly more marked for the easy than for the difficult materials.
(*c*) Reading comprehension is more variable than listening comprehension.
(*d*) The more intelligent and more rapid reading groups score higher in both reading and listening comprehension than do the less intelligent groups.
(*e*) Equivalence of passages for reading comprehension does not ensure their equivalence for listening comprehension.

In the classroom situation, the learning medium used must depend on the level of difficulty of the material, thus for easy material, listening may be better than reading but the relative superiority of listening comprehension over reading comprehension diminishes with increasing difficulty of material.

One thing does stand out clearly from the published results of these researches—listening comprehension, like reading comprehension, is a complex skill; and tests of word meaning, word recognition, English usage, recall, intelligence and so on only give particular facets of this skill.

Most of the research work in this country on the efficiency of listening and recall has been concerned with adult listening (5, 6). An experiment was recently carried out by the author to compare the results obtained by children on different types of comprehension passages when these were presented (*a*) orally—as listening material, and (*b*) visually—as reading material. One point clearly emerged from these results: a single mark on one comprehension test (given orally or visually) was not a valid or reliable mark for assessment of comprehension, and a number of short passages with variety in content might prove to be a more useful guide. Some of the published results of researches on the marking of the essay are similar in this respect.

Ten comprehension passages were used in the above research and two of these were chosen which were of similar difficulty and interest for boys and girls whether presented orally or visually. 175 boys and girls in the last term of their junior schools read the first test and then answered a set of questions on the contents. Exactly a week later the same children were given the same set of questions which they answered from memory. These children were given the second passage orally, answered the questions and a week later answered the same set of questions from memory. 221 boys and girls also took the same tests in the reverse order, i.e. oral test followed by reading test. In addition, results of an intelligence test were available so that for each child there was (i) score on an intelligence test, (ii) score on immediate recall of reading material, (iii) score on delayed recall of reading material (one week later), (iv) score on immediate recall of listening material and (v) score on delayed recall of listening material (one week later). Great care was taken to standardise the test procedure in the different schools.

No significant difference was found between the mean scores of boys and girls in the intelligence test. The order of presentation of the comprehension tests (visual, oral; oral, visual) did not introduce a differential practice effect.

There was no significant difference between the mean scores of boys and girls on the listening test and its recall but there was a significant drop (0·01 level) in mean scores for both boys and girls between these two tests. There was some evidence that girls recalled slightly less than the boys. This difference is difficult to explain but it may be linked to the increase in mean score found with the boys' results in the recall of the reading passage. This particular increase was slight and certainly not significant. It was unlikely, judging by the results of the previous research in which these passages were used, that the boys were more interested than the girls; perhaps the boys were not so backward in guessing and guessed more successfully. However, it is important to note that between the reading test and its recall there was no significant difference for boys and girls.

Initial scores for boys and girls were higher on the listening test than on the reading test and these differences in mean scores were significant at the 0·02 level; however, the differences in means on the immediate and delayed recall scores for both boys and girls were not significant. The initial advantage that the listening test had over the reading test seemed to have vanished at the end of a week: there was very little difference between the amount of information retained which ever method of presentation was used.

The boys' intercorrelations on the results of the five tests were consistently higher than those of the girls, and for both sexes the correlations of intelligence test scores with scores of the immediate and delayed recall of the reading tests were significantly higher than those for the immediate and delayed recall of the listening tests. The correlation of boys' and girls' scores between the immediate and delayed recall of the reading material was 0·81 and the corresponding correlation for the listening material was 0·70. The correlation between reading and listening comprehension, measured by immediate recall, was 0·51 for boys and 0·35 for girls, much smaller than the 0·78 reported by Goldstein with training college students. The value of the correlations of the four tests with the intelligence test shows a steady decline; with immediate recall of reading material 0·69, with delayed recall of reading material 0·62; with immediate recall of listening material 0·49, and with delayed recall of listening material 0·44.

A comparison of the results of the four tests for children in the top and bottom thirds of the rank order on the intelligence test scores showed some divergences from the pattern already noted in the complete sample. Both boys and girls in the lower third group did much better when listening than when reading (both mean differences were significant at the 0·01 level). Boys and girls in the top third group also returned higher scores on the listening test than on the reading test. The difference between boys' means was nearly significant at the 0·05 level but the difference between the girls' means was not significant. The boys in the upper third returned significantly higher scores on the delayed recall of the reading test (the difference was significant at the 0·02 level). The girls showed the same trend, but the difference was not significant. The boys and girls in the lower third group returned higher scores on delayed recall of the listening test; the differences were not significant though evidence showed that girls retained slightly more of the facts than the boys.

Considering the sample of boys and girls, there seems to be some evidence that for immediate recall, listening is more effective than reading; but the effects at the end of a week are not significantly different. However the brightest boys and, to a lesser extent, the brightest girls recall facts better when the material is read by them. The nature of the classroom approach to learning was outside the scope of this research, but it would be interesting to know, in view of Rankin's statement on the apportionment of school time, whether the more formal method of teaching meant that for many children listening rather than reading was the preferred method of gaining information. The results of this research seem to show that the less academically inclined children tend to absorb initially more facts if these are presented orally. At least, from the teaching point of view, these results underline the need for the reinforcement of the amount of material recalled by making use of both methods of presentation, i.e. presentation, where possible, by sight and sound.

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HANDICAPS TO SUCCESS AT THE UNIVERSITY

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1. DESCRIPTION OF THE STUDY

IN the course of a general research (1) on academic success and failure of undergraduates at the university, information was obtained on students' subjective views of the reasons why they had failed to graduate, or had not obtained as good examination results as they might have.

This article summarises the descriptions given by 380 past students of University College London of some of the difficulties encountered during their undergraduate days, which they considered had appreciably handicapped them in their work.

The question they answered was included in a fairly lengthy questionnaire which was completed by 212 successful students and 176 students who failed to graduate. Further details concerning these samples are given elsewhere (2).

The question, which was worded slightly differently for failed students and for successful graduates, asked for an account of the factors, if any, which the students felt had detracted from their academic performance and for a discussion of the ways in which they considered their difficulties had arisen.

Many of the students from the graduate group gave, in addition, an account of the reasons which they felt had contributed to their academic success. These are summarised towards the end of this report and discussed in relation to the main findings.

The replies obtained were usually very lengthy and detailed. Most respondents covered well over half a page, and many wrote close on two pages. The coding of the replies was done independently by two judges and was carried out according to certain arbitrary rules. Every reason given by a student as having contributed to his difficulties was considered as one item, no attempt being made to assess the relative importance of the different reasons, nor to gauge the degree of certainty with which they were given. Items mentioned casually appear in the analysis in the same way as others that were heavily emphasised. Only those reasons were included that had been explicitly mentioned: a review of the original data would certainly show a large number of reasons deliberately or unconsciously implied rather than stated, a few with unambiguous clarity; but for the present report they have been ignored.

2. Analysis of the Results

"Not doing enough work" is the most important single reason given for not achieving optimum academic performance. This opinion, that study was insufficient and inadequate, appears explicitly in nearly 70% of the questionnaires and implicitly in about another 15%-20%. To give such a reason seemed to amount to a social norm. All other reasons offered by the respondents were in fact usually attempts at explaining why enough work had not been done. This paper is concerned with these other reasons and their alleged interference with study. "Not doing enough work" has therefore not been included as a separate item in the presentation of the results (3).

Eventually forty-six different reasons were coded, and thirty-five of these appear in common among both the failed group and the graduate group. There is undoubtedly overlap between some of the reasons as they are classified here. For example, "dislike of university life" and "uncongenial atmosphere" probably refer to very similar feelings. It would thus be possible to group many items under higher-order headings such as "Social", "Psychological", "Educational" and so on. However, there would certainly still be overlap in many instances, and the more general the headings the less detectable this would become. Although an attempt has been made to summarise the data under such general headings (Table 2) it was considered

TABLE 1

Number of Past Students reporting Difficulties, and Sum of the Reasons reported

	Both Groups	*Graduate Group*	*Failed Group*
Number of students	380	204	176
Number of reasons given,			
(*a*) appearing in both groups	985	424	561
(*b*) not appearing in both groups	38	10	28
Average number of reasons given per person	3·0	2·9	3·2
Range of number of reasons given	1-8	1-6	1-8

desirable to present the material in as much detail as possible. Fortunately, as the respondents usually gave full and clear answers, it was possible to classify together numbers of very closely similar replies with a minimum of inference and uncertainty.

All respondents gave some answer to the question but eight from the graduate group—seven of whom had obtained first class degrees or upper seconds, and one a third—stated having encountered no particular difficulty. These have not been included in the totals.

The basic data are summarised in Table 1.

The reasons appearing in common in both groups were roughly classified under a few general headings, as shown below, where the number of replies under each heading is shown as a percentage of the total number of persons reporting difficulties:

(*a*) Extraneous and accidental (67%)
(*b*) Psychological and "personality" (60%)
(*c*) Educational (i) criticism and blaming of school or university (45%)
(*d*) Educational (ii) no criticism or blaming of school or university; includes e.g. "inefficient study" (45%)
(*e*) Social, including "sport" (33%)

Table 2 shows the frequency of occurrence of each one of the thirty-five reasons appearing in the replies of both groups of subjects. The letter a, b, c, d or e prefixing each item refers to the classification adopted for the more general summary as given above.

It can be seen from the data of Table 2 that the percentages of some reasons differ considerably from the failed group to the graduate group. For example, "Too many distractions", is given by nearly twice as many from the failed group (13%) as from the graduate group (7%). "Place of living" ranks first with the failed group—as it does also with the combined groups—whereas it holds third rank with the graduate group. It must be admitted that the validity of the reasons given cannot be assessed from the data. Particularly with the failed group, one may be left with the suspicion that many of the reasons are rationalisations for not having succeeded in graduating.

It is, therefore, especially interesting to find that there is in fact good general agreement between the reasons given by the graduate group—who, it may be assumed, has less cause for finding excuses for their limitations—and the failed group. The rank correlation coefficient has a value of 0.5 and is highly significant.

TABLE 2

FREQUENCY TABLE OF REASONS GIVEN AS HANDICAPPING ACADEMIC SUCCESS

(The figures are percentages to the nearest unit of the total number of persons in the group)

	Reasons Given	*Combined Groups* ($N=380$) %	*Graduate Group* ($N=204$) %	*Failed Group* ($N=176$) %
a	Unsuitable place of residence	22	16	28
a	Excessive travelling time	18	19	18
c	Inadequate teaching	17	18	16
a	Lack of money	14	12	15
b	Poor concentration	13	13	14
d	Wrong choice of subject, and lack of interest	13	9	18
c	Inadequate pre-university preparation	11	2	22
b	Difficulty in transition from school or the armed forces to university	11	8	15
c	Insufficient supervision and tutorials	11	7	15
d	Bad study methods	11	10	11
e	Too many distractions	10	7	13
b	Sex difficulties	8	9	8
d	Marked weakness in one subject	8	3	15
b	Psychological difficulties	8	4	12
e	Too many outside activities	7	7	7
b	Wrong age, and immaturity	7	5	9
c	Dissatisfaction with syllabus	6	4	8
d	Overwork	6	5	6
d	Insufficient questioning of teaching staff	5	4	7
a	Uncongenial atmosphere of the college	5	5	5
a	Physical illness	4	3	6
e	Too few social activities	4	2	6
e	Too little participation in Union	4	1	6
b	Stress of examinations	3	1	5
e	Too much sport	3	3	3
b	Lack of confidence	3	3	2
e	Too much activity in Union	3	4	1
e	Unsuitable companions	2	2	2
a	Inadequate library facilities	2	3	1
d	Insufficient discussion with students	2	1	2
b	Dislike of university life	2	1	3
a	Effects (physical) of living in town	2	1	2
e	Not enough sport	1	1	0

3. Comments and Examples

A few examples may be given to facilitate the interpretation of some of the items in Table 2.

The "place of residence" refers to living in university or college halls of residence, in lodgings, with relatives, in a flat, or at home with parents. In the replies the objection was most often made that there was not enough privacy for working. Typical comments were: "It was impossible to work because the wireless was always on"; "My parents did not have the slightest understanding of what university work was like"; "My mother kept fussing about my working too hard and bringing me cups of tea".

Students living at home often complained that they felt too much cut off from university life. Some indicated also that living at home prevented their achieving the independence which they felt they wanted. Only four respondents were dissatisfied with living in college halls. Fifty-three regretted having lived at home as students, and twenty-six regretted having lived in lodgings or a flat. Entries were not recorded under this heading when it was apparent that the objection to the place of residence was only due to distance from the college—the entry then being made under "Travelling time".

A lengthy journey to and from the university was one of the things which were most emphatically reported as being irksome and depressing. Both Dale (4) and Mountford (5) have referred to this problem and recognised its importance. In the present research this complaint produced some surprising admissions. Many students journeyed one to two hours to reach the college. One wrote that he travelled over 120 miles a day. Few of the students who lived more than about half an hour's travelling away from the college failed to mention this as one of their chief difficulties. Here are some of the comments: "I only wish I hadn't had to travel daily in the rush hour. I got home exhausted and feeling only like listening to the wireless instead of working"; "It was a relief when I had no lectures to stay home and not have that journey"; and, "The only real difficulty was travelling to and from college".

The criticisms of the teaching staff generally referred to what was felt to be a poor standard of lecturing. Remarks such as, "Apart from one or two, they just couldn't teach", appeared about a dozen times. Very often it was clear that a respondent was using good school teaching as a standard against which to judge university lecturing. Other criticisms were more specific: "One lecturer could never be heard beyond the second row"; and, "Lecturers always seemed to assume we knew more than we did. To me it just sounded as if they were showing off." One of the most recurrent themes expressed the feeling that lecturers were "interested in research but not in the students". This sort of remark appears about as frequently in the graduate group as in the failed group. Almost half the graduate group (and a few from the failed group) describe the teaching staffs as being very easily accessible and helpful. Some of these, indeed, mention the lecturers' interest in research, but far from complaining about it remark that they found it stimulating and valuable to themselves.

About 13% of the ex-students said they had not had enough money, and there were apparently a few very marked cases of hardship. It is not possible to tell how far any of these may have been exaggerated, but at least some students were very definite that they had to live in lodgings on grants of £290 a year and received nothing from home; and some wrote that they were obliged to earn money in the evenings and at the weekends during term, as well as to take employment in the vacations. Generally speaking, however, the complaints were fairly mild and hardly amounted to real handicaps. The following is a typical example: "I could have had a more interesting life if I'd had a little more money. I might have mixed with more people. As it was, I had to be conscious of every sixpence I spent." A few students from the graduate group specifically recognised that having "no worry about money" had been a positive factor in their studies.

Too many students appeared to have chosen to study the wrong subject. Sometimes they discovered, too late, what subjects they would have preferred, though more often they admitted never having been strongly attracted to any particular area of study. Others claimed that they had wanted to take a particular subject but had been advised—at school, or at home—to take another. For example, one woman student wrote, "My headmistress thought I should take classics, so I did. I never really liked it." A medical student, who had wanted to be a schoolteacher, said, "My parents were very keen I should become a doctor."

The risk of succumbing to the many distractions of university life (and of life in London) was clearly too great for many students. One wrote, "I was always idling in the Students Union, just chatting." Other comments are similar: "I went to theatres far too many times in the term, and to all the dances"; and, "I liked to go out drinking —always thought I could work later on."

There were some rather more positive occupations, also timeconsuming to the detriment of work (e.g. Table 2: "Outside Activities"). One student said he played chess "at least three hours a day". Many continued to attend various associations, church societies, or social clubs near their homes.

There were many students admitting to various kinds of psychological difficulties, including sex difficulties. Many more showed clearly, but indirectly, that they suffered these handicaps, but following the rule of only recording explicit comments they are not included in the totals. This kind of remark appeared frequently: "I had a pathologically intense sense of inferiority" (This person had psychoanalytic treatment on leaving the college halfway through the second year); "I was twenty-two when I came up to college and had hardly ever spoken to a girl"; and, "I found it worrying being in the company of women". Others reported difficult love affairs which kept them depressed or anxious for long periods. All five students who married during their period of residence, spontaneously reported feeling more stable and more efficient as a result.

4. Additional Results from the Graduate Group

Many of the students from the graduate group gave, in addition, an account of the reasons which they felt had contributed to their academic success. Altogether 132 questionnaires were analysed, giving a total of 21 different reasons. These are summarised in Table 3.

TABLE 3

Frequency Table of Reasons Given as contributing to Academic Success

(The figures are percentages of the total number of persons in this group)

Reasons given	*Graduate Group* ($N=132$) %	*Reasons given*	*Graduate Group* ($N=132$) %
Staff and teaching	45	Discussions with students	4
Place of residence	36	Lack of worries	4
Hard work	29	Outside activities	4
Interest	19	No anxiety about money	4
Efficient study methods	14	Good school preparation	4
Good choice of companions	10	Social life	4
Sport	8	Wish to please parents	4
Ability; intelligence	7	Competence at one subject	2
Sex relationships	7	Fear of failure	2
Good health	7	Luck	1
Determination	6		

Comparison of Table 2 and Table 3 shows that some of the reasons which figured high up in the list of handicaps and difficulties are also frequently mentioned among the reasons for success. This is true of comments about teaching, and about place of residence. Regarding place of residence, "Living at home" is again mentioned more frequently (29 cases) than lodgings (14 cases) or college hall (5 cases).

There are altogether 16 items which some students considered were handicaps but which others felt had contributed to their successes. Some of these have, of course, opposite meanings in the two lists (e.g. "Inefficient study methods", and "Efficient study methods") but nonetheless they refer to precisely the same kinds of factors.

5. Conclusion

The interpretation of the findings reported above is naturally restricted by the limitations of the data, which amounted to unverified subjective impressions given retrospectively. Ultimately one should be concerned with establishing more firmly and objectively the basis of such dissatisfactions as were spontaneously expressed in reply to this questionnaire. It is also necessary to assess objectively their relative importance as handicaps to successful study.

A dissatisfaction, however, need not only be judged in terms of its basis in fact. The value of the present research is mainly to give some information about the ways in which students view the problem of inefficient study and the ways in which they consider their competence as students to be vulnerable. In this connexion the close agreement between the reasons given by the failed and the graduate groups, and the similarity between the items listed as handicaps and those listed as advantages, are particularly relevant. They appear to reveal at least some of the features of an undergraduate environment which are experienced by students as being dominant, and in terms of which they structure their views of themselves as students.

For example, one of these is teaching. The students who complain about the standard of lecturing, like those who praise it, are showing thereby that they view themselves as pupils who have come to be taught. (It is interesting that the complaint was never made that the work was too hard—only that it was poorly taught.) This view is, of course, completely justified, but it is neither inevitable nor inescapable. Recent interviews with students have showed that some—comparatively few—consider lectures almost as incidentals to their study. However, a student who very largely considers his role to be that of a member of an audience will probably be more affected, favourably or unfavourably, by the quality of the lecturing than if he considers attendance at lectures merely to be one of the means of study at his disposal—similar to, and on a par with, reading privately and writing essays.

To take another example, it may well be that the "place of residence" (particularly living at home) assumes special importance in quite a high proportion of cases because it represents acceptance of or conflict with parental influence, this being a problem which would be outstanding for a great many adolescents. And apart from certain cases of truly intolerable lodgings or home conditions, a student would feel that where he lived was favourable or unfavourable to study largely—if not only—in accordance with the personal adjustment already achieved by himself in relation to the family group.

Interpreted in this sort of way the questionnaire replies suggest that the main subjectively outstanding features of the undergraduate's world may be fairly few. Roughly the same sorts of items are singled out for mention as handicaps and as advantages, and successful students have roughly the same complaints as failed ones.

The lists of items obtained here need not, of course, be considered exhaustive. More research is needed to discover what in fact the main pivots in a student's existence are likely to be (6). This amounts to discovering more about the ways in which undergraduates view their responsibilities and functions as students. It amounts also to seeing, in comparable terms, what are the implicit expectations that academic staffs and undergraduates may have about their reciprocal relationships.

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THE ROLE OF T. H. HUXLEY IN THE DEVELOPMENT OF UNIVERSITIES IN THE NINETEENTH CENTURY

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THE lifetime of T. H. Huxley, from 1825 to 1895, spanned the great period of university reform in England and university foundation throughout great areas of the western world. One of the generation which first saw science given some proper place in university studies, himself not only a scientist but a deep thinker about education and a most skilful educational politician, Huxley was able to play a greater role in university development than has usually been recognised (1).

In the middle of the nineteenth century, both Oxford and Cambridge were slowly emerging from a century of near-slumber, but their atmosphere was still one to stifle a young iconoclast like Huxley. Not surprisingly, he turned down tempting offers and stayed in his London laboratory; but, acting through friends and pulling every string to which he could lay finger, he exerted a considerable influence on both the ancient universities of England. Already in 1860, the year in which he trounced the Bishop of Oxford in the great Darwinian debate, Huxley had secured the appointment of the physician George Rolleston to the newly instituted Linacre Chair of Physiology, and through him he was able to influence the conduct of science examinations and the selection of a new professor of botany. Then, in 1872, it was largely Huxley's doing that E. R. Lankester was elected Biology Fellow of Exeter College and so made another channel into Oxford for the influence of his master. By 1888, when the Linacre Chair again fell vacant, Huxley was powerful enough to mobilise such support from scientists as to secure Lankester's appointment against the wishes of the Archbishop of Canterbury, who wanted the post for his own cousin. Acting in this way behind the scenes rather than in the limelight of official position, through the years he chose a Biology Fellow for University College and another for Merton College, supported G. J. Romanes in securing a new biological laboratory, helped E. B. Poulton to gain the Hope Chair of Zoology, and was one of those who brought J. J. Sylvester back from America to be Savilian Professor of Geometry when the religious test which excluded Jews was abolished at Oxford (2).

Much the same tale can be told of Cambridge. It was at Huxley's urging that Trinity College in 1870 founded the Praelectorship in Physiology, and it was his nominee Michael Foster who was appointed to it. Through Foster, Huxley's influence was channelled to Cambridge science, as it was later when he chose the brilliant young biologist F. M. Balfour as a Trinity Fellow in 1874 and Adam Sedgwick as another Fellow of the same college in 1880. Later, he was appointed an elector to the Cambridge Chairs of Physiology, Anatomy, and Zoology and Comparative Anatomy (3).

However, Huxley's interventions at the two ancient universities of England were by no means confined to the staffing and development of the science departments. At Cambridge he was one of those who in 1878 attempted to remove the requirement of compulsory Greek in the Previous Examination for all who wished to take an honours degree, and his letter to the Vice-Chancellor was unquestionably the most cogent of those submitted; he was, too, one of those who sought in 1880 to persuade Cambridge to admit women to its degrees: the fact that so many years were to go before the university gave effect to either of these reforms is a testimony to the power of entrenched conservatism. At Oxford, also, there was opposition to change, but Benjamin Jowett and Huxley and their allies succeeded in removing Latin and Greek as compulsory elements in the degree course (4). And when, having initiated the Merton Chair of English Language and Literature on the recommendation of the Commission of 1877-80, Oxford proceeded to appoint a philologist to it, Huxley's voice of protest was perhaps the most powerful of those raised (much more so than that of Matthew Arnold, for example) and he was thus partly responsible for the establishment in Oxford of a Final Honours School of English Literature (5).

With the universities of Scotland Huxley had more official connexion, being very nearly elected Rector of St. Andrews in 1872, being Rector of Aberdeen from 1872 to 1875, acting as Professor of Natural History *locum tenens* at Edinburgh in 1875 and 1876, and being a member of the Royal Commission on the Universities of Scotland from 1876 to 1878. The detailed newspaper reports of the two rectorial election campaigns show that Huxley's candidature acted as a focus for the students' discontent with ancient university ways and for their determination to press not only for adequate science teaching and the improvement of medical education, but also for university reform generally: they also show how bitter was the *odium theologicum* attached to "Darwin's bulldog" and testify to the prestige which Huxley must have had to win in the face of Presbyterian orthodoxy (6). At Aberdeen, Huxley broke with the custom that the Rector was a merely decorative officer and pressed actively for religious toleration, the removal of compulsory Greek for medical students and its replacement by a modern language, the more efficient organisation of the medical course, and the admission of the sciences to the university on equal terms with the arts; and, although none of these reforms was completed during his three years as Rector, the ground he broke brought forth fruit in the years that followed (7). And, even at Edinburgh, where he held no such position of prestige, Huxley managed to get some of his protégés into university posts and to apply some pressure towards the reform of the curriculum (8).

Meanwhile, as the older universities of the two kingdoms slowly came into line with the times, Huxley applied himself to the new universities growing up elsewhere. In manufacturing Birmingham he delivered the 1880 inaugural address at Sir Josiah Mason's Science College, but much more important was his connexion with Owens College in industrial Manchester. Recognised by its 1870 Act as the embryo of a future university, the reorganised Owens College had Huxley as one of its Crown Governors and a member of its Council from the start. He urged that history and literature and the creative arts should not be neglected in a one-sided pursuit of science, and especially commended the close propinquity of the faculties of arts and sciences. Typically, he pressed for the more methodical teaching of science, was partly responsible for the establishment of the chair of physiology, had a hand in the appointment of the first professor of anatomy, opened the fine new medical school buildings in 1874, and was one of those who were present when in 1880 Owens College metamorphosed into the Victoria University, parent of several of the provincial universities of England (9).

Across the water in Ireland, Huxley also had a finger in several pies. He lectured at Dublin's ancient Trinity College, and he secured the appointment of J. Cleland as professor of anatomy and physiology at Galway's newer Queen's College and of C. W. Thomson as professor of botany at Dublin's Royal College of Science. Moreover, as a member of both the 1866 Royal Commission on the Royal College of Science for Ireland and the 1868 Commission on Science and Art Instruction in Ireland, Huxley had a say in settling the general shape of Ireland's university structure (10).

Over wider seas, too, his influence stretched. Agassiz of Harvard and Haeckel of Jena and Kölliker of Wurtzburg and Dohrn of Naples were in touch with him over many years; von Baer of St. Petersburg and Dorpat, van Beneden of Liège and Louvain, Brown-Sequard of Paris, Carus of Leipzig, were all in correspondence; in the University of Calcutta his *Science Primer* was a prescribed text, in the University of Riga a lecturer wanted to translate it into Russian, others of his books appeared in French and German and Hungarian and Portuguese and Polish. The new Johns Hopkins University at Baltimore called on Huxley to deliver its inaugural address and to provide its first professor of biology—and, just as H. N. Martin transplanted Huxley's methods to Johns Hopkins, so did H. F. Osborn to Princeton and others to the State University of Minesota and to the great Peabody Museum at Yale. One ex-pupil, Enrico Gigliogli, bore his master's influence to the University of Casale; another, Charles Gould, bore it to Singapore; T. J. Parker to New Zealand; others, no doubt, we know not where (11).

It was, however, with the colleges and university of his own great metropolis that Huxley was most intimately connected. He was one of the Governors of London's secular University College and had a good deal to do with the establishment there of the Jodrell Chairs of Physiology and of Comparative Anatomy and Zoology; he supported the University of London Extension movement to take lectures of university quality to the general public; he was a leading light in the movement to provide for the proletariat of East London that "People's Palace" which grew into Queen Mary College. More important, it was he more than any other man who was responsible for fostering the growth of the Government School of Mines into the great Royal College of Science; he as much as any who saw to it that the funds of the wealthy city guilds were applied to the financing of the City and Guilds College; and so, if one man could be selected as the builder of the great Imperial College of Science and Technology formed by the fusion of these three institutions, that one would be Huxley (12).

The University of London itself during Huxley's lifetime was little more than an examining body, but by its examinations it wielded great influence over university education throughout the imperial realms. Examiner in physiology and anatomy and zoology for some fifteen years, he tried to make even examinations an instrument of scientific education; the improvement in the university's medical requirements (which set the pace for medical schools throughout the kingdom) was due largely to his influence; he was among those who secured the institution of degrees in the natural sciences. From 1883 he was a Crown Fellow and Governor of the University of London and he played a key part in the movement for the reform and reorganisation of the university as an effective teaching body. The many committees which sprang up, representing the university and the various metropolitan colleges and the professoriate, present a tangled pattern of conflicting hues; but, running straight through them, the strong line of Huxley's influence can be clearly discerned. Huxley did not live to see the new University of London, a university in the fullest sense, but he had had much to do with its conception (13).

Thus, though not usually counted among the great university reformers, T. H. Huxley in fact accomplished by indefatigable string-pulling much more than many others did by the normal occupancy of official positions. Wide awake to the changes already taking place in society and percipient of those yet to come, he saw how universities needed adaptation if they were to cater for new needs and yet not lose their ancient virtues. He has a secure place in the history of university development during the nineteenth century.

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BOOK NOTICES

SECONDARY CURRICULUM

GEORGE Z. F. BEREDAY and JOSEPH A. LAUWERYS (eds.): *The Year Book of Education*, 1958. *The Secondary School Curriculum* (Evans, 1958, 63s.)

AMIDST the controversies about what kind of secondary schools children shall attend it is salutary to learn that much thought is being given to what children shall be taught in these schools. Everywhere there is change, with every country examining whether the education it gives its children is the best for life in the modern, technological world. Because Russia gives its pupils so much mathematics, science and foreign languages, is it necessary for all others to follow suit? Although the final answer will not be found in its pages *The Year Book of Education for 1958*, with the sub-title *The Secondary School Curriculum*, will encourage all connected with education to experiment. It deals in five sections with the secondary school curriculum—Its Tradition; Aims and Objectives; The Curriculum in the Educational Pattern; The Influence of Social Circumstances; Theories of Education and Curriculum Reform. Its chapters, written by specialists from eighteen countries in all parts of the world, emphasise what is usual, not what is unusual. It concentrates on the secondary school stage because it is here that the rapidly changing economic scene has its greatest impact on schools.

Before any reform in the curriculum can take place the teachers' co-operation is essential; not enough emphasis is placed here on how this can be achieved. But each writer shows he is aware that education is now a major social problem. Writers from different countries try to put forward their aims of education in the light of the emergence of a changed social order and of the great advance in scientific and technical knowledge. One of the most encouraging signs is that throughout the volume it is made clear that fuller knowledge of how a child learns is the best guide to curriculum reform.

Some of the more stimulating chapters examine the aims of education. The writers agree that democracy to-day demands that its peoples shall be scientifically literate, technically skilful and socially intelligent. All see the curriculum as an instrument to achieve these aims, but there is by no means uniformity. While individual headmasters in England retain the greatest influence on what shall be taught in their schools, in Russia the demands of society dictate the curriculum. Similarly, in China it must serve the people by helping to build socialism. Israel enforces a state curriculum in the hope of integrating quickly its many different racial communities. America, with its emphasis on freedom inside the school, includes wide general study with vocational work. The difficulties in planning curricula are shown best by the efforts of some of the new countries which have grown to nationhood since the last war. Ghana is an example, wondering what to take from the past and yet anxious to give its children what is vital for a technological age.

It is encouraging to note that England is not lagging behind in planning the curriculum. The emergence of the ninth examining board is shown and the work of many secondary modern schools in moving towards vocational studies on scientific and technological lines is examined. But perhaps the most interesting factor that emerges from this lengthy volume is the importance of the teacher-child relationship. In most countries and in all kinds of schools it is being more and more recognised that, to achieve an effective curriculum, planners must begin from the learner's point of view. It is the pupil who should dictate the ultimate curriculum decisions. The training of teachers should place much more emphasis on the understanding of children's needs.

The *Year Book*, with its forty-nine chapters, offers no ready-made solutions to our problems but will serve as an excellent reference book for those who wish to keep abreast of what is happening in curriculum-planning throughout the world.

H. C. HONEYBONE

PUPILS' THINKING

B. INHELDER AND J. PIAGET, *The Growth of Logical Thinking from Childhood to Adolescence* (Routledge, London, 1958, 32s.).

J. S. BRUNER, J. J. GOODNOW and G. A. AUSTIN, *A Study of Thinking* (John Wiley, New York, 1957, 44s.).

R. W. YOUNG, *Lines of Thought* (O.U.P., 1958, 8s. 6d.).

THESE books represent three quite different ways of dealing with the problem of thinking. The first is a study of the fundamental thinking operations carried out by pupils between the ages of 7 and 15 when they are confronted with science experiments requiring inductive and deductive reasoning for their interpretation. The theoretical schema of operations used is that developed by Piaget.

The second book touches similar ground in dealing with the problem of categorising and describes the strategies by which the particular cues are combined and sifted in order to form concepts. It opens up a new technique for investigating thought processes.

The last book does not aim to explain thinking but "to give sixth formers some training in independent and responsible thinking". This is a valuable objective in these days of overloaded specialism in the sixth form.

The Growth of Logical Thinking is not a book for the beginner. It is, however, a first-class monograph for the serious student of Piaget's work. It studies the problem of logical judgment over the primary and secondary school years and this gives it added value to the advanced research student in education. Before embarking upon it, the reader will do well to look again at Piaget's small book *Logic and Psychology* (Manchester University Press, 6s.), studying in particular Chapter II and W. Mays' short introduction on Piaget's system of logic; this may be followed up by the useful translator's introduction by Anne Parsons to the book under review. The would-be reader will then be prepared for the main work, which consists of a series of "science" and "probability" experiments conducted by Inhelder and designed to test various levels of logical thinking. Piaget contributes a discussion of the results of each experiment in terms of the symbolic logic he has devised to describe the operations of children's thought.

The experiments chosen and the results obtained by asking children to carry them out and explain their consequences are very impressive. Teachers of science will recognise the erroneous responses, interpretations and constructions that they meet so often in the lower and middle school science lessons of secondary schools. This empirical part of the work is very authentic and convincing.

In order, however, to grasp its theoretical significance in terms of the Piaget model, the reader must be clear about one important suggestion regarding the adolescent's logical thinking. This is the change in *quality* of the thinking, described in Piaget's terms when the child passes from the stage of being able to carry out "concrete operations" to that of being able to carry out "hypothetico-deductive reasoning".

At the stage of "concrete operations" the young experimenter, from seven years of age upwards, is able to compare classes of events, such as angles of incidence and angles of reflection, or deflections of rods with weights and lengths. He is able to serialise the events in the two classes. He is able to correlate them. He is able to set up practically the experimental conditions necessary for certain results. But he does not seem capable of formulating hypotheses or propositions concerning the effect of one variable upon another, or concerning any other relationship between two variables. Nor is he able to test out such hypotheses in a systematic way. This final stage of propositional thinking is reached only towards 14 years of age.

Unless the reader has clearly grasped this difference in the quality of the pupil's reasoning, he will not derive the best from Piaget's theoretical discussion on the results of the experiments nor from the last chapter on adolescent thinking.

A Study of Thinking is also a work primarily of value to the research worker. The close similarity to Piaget's suggestions shows regularly through the discussion, but the authors place their work more clearly in the setting of contemporary theories of learning and cognition.

A series of experiments is described in the main body of the book, designed to show how concepts are attained. Arrays of abstract and thematic items are presented, each embodying three or four different categories: colour, shape and number in the case of the former and sex, apparel and mood in the case of the pictorial themes. Various types of strategy, by which the thinker attains given concepts, embodied in items chosen by the experimenter, are brought to light under various experimental conditions. An interesting appendix by R. W. Brown on linguistic categories provides examples of the processes described earlier.

There seems possibly a link with Piaget's theory in that more mature subjects reveal a more co-ordinated pattern of testing of hypotheses. This applies also to the scanning strategies revealed by Bruner, Goodnow and Austin. There is a similarity between their methods and the experiment described by Inhelder and Piaget in Chapter 6 of their work.

The book as a whole is a first-class piece of experimental psychology and adds to our knowledge of the psychology of thinking. It is a valuable complement to Piaget's work to which it is superior in the way the problem is related to current trends in psychology. It is less directly applicable to school work but should be studied by research personnel working upon thinking and reasoning problems and by teachers especially interested in how the minds of their pupils function in problem situations.

The author of *Lines of Thought* makes use of material from all the main branches of human intellectual activity and deals with linguistic and logical difficulties. Although this book has not the pretensions of the first two publications, it can be read by the research student in conjunction with them, as many of the exercises given illustrate very well the points made, particularly by Inhelder and Piaget.

As a teaching aid, designed to make sixth formers a little more discriminating and critical in relation to all the material they read, this book has a very useful part to play and can be strongly recommended. Every sixth former, no matter what his specialism, should go through all the passages and exercises.

E. A. PEEL

THE THREE-YEAR COURSE

W. F. MORLEY, R. GOULD, W. P. ALEXANDER and W. R. NIBLETT, *Three-Year Teacher Training* (Methuen, London, 1958, 3s. 6d.).

As Sir Ronald Gould says in his contribution to these lectures, given at the College of Preceptors, "the three-year course has been discussed . . . so often that, possibly, there is little new that can be said about it", yet this publication manages to be stimulating, controversial and constructive.

Canon Fenton Morley deals with the purpose of training and examines the relationship between the modern environment and education and, in particular, teacher training. He thinks there is some danger that education will become divorced from reality, "more concerned with the transmission of culture than the development of culture, shaped to meet the needs of a pattern which has ceased to exist", but also warns against the opposite danger, a too ready willingness to be deflected from our ends by transient pressures. Teacher training, he feels, must take into account such important trends as the lengthening of school life, the changing effect of one stage of education on another, secondary on junior, university on secondary, the demand for better scientific and technical education, the advent of television, the need for education for leisure and for better personal relationships. Although the forces within modern society discussed by this contributor seem to the reviewer to be of unequal importance for teacher training, it is very salutary to be reminded of them, for the temptation to forget the world of 1968 in solving the conundrum of which main courses to set up in each college, and which particular shortage of teachers to supply next, is very great.

The theme of the relationship of training to environment is taken up by Sir Ronald Gould, who is especially concerned with the relationship of the training of teachers to the unity of the profession. After detailed discussion of the possible roads to that goal, he makes the point that we must end the dichotomy between the teacher in the secondary grammar field who is expected to be something of a scholar but may be trained or untrained, and the teacher in the primary or secondary modern school who is not expected to be a scholar but is always trained.

The reviewer thinks that, in the best training colleges, stress is laid not on training, in the narrow sense, but on the relevance of scholarship to education, and that this is precisely why some training college students appear to have thought more deeply about their subjects than some graduates, although the degree course may have been much more extensive. No-one could disagree with Sir Ronald's conclusion, however, that the teacher of the future should have both scholarship and training.

Dr Alexander has usually some root and branch proposal and he certainly has one in this lecture. There is little doubt that his ideal, the four-year course for all teachers, is the goal to aim at, whether we organise it as he suggests, or not. It seems clear, too, that the typical college of the future will be much larger than at present, even if, though already habituated to the idea of a college of 500, we still blench at one of 1000. However large the college, the important point is to see that the small groupings within it are genuinely effective, and that the merits of a rural community and a specialised contribution are fully considered before sweeping changes of "urbanisation" and "generalisation" are made. Dr Alexander's great virtue is that he is not afraid to ask for a generous policy and to remind us that what we ask is not revolutionary in comparison with the importance of the work in hand.

The last lecture in the publication is by Professor Niblett, whose understanding of the genuine progress made by many training colleges, especially in the last decade, is very welcome. Under the title "Ideas and Reality in Teacher Training" he deals with such matters as the qualities and qualifications of entrants, the quality and flow of staff, the maturity of students and the relevance of the pattern of college life to some of these issues. He discusses the programme of the three-year course in more detail than the other contributors, and lays stress on the need for time to think. He plans a suitable allocation of time for a secondary student but, in the opinion of this reviewer, rather begs the question by avoiding the more difficult problem of how to safeguard the time of a primary student with a wider spread of curriculum courses, or of a student taking a practical subject with its inevitably heavier time-table.

To some extent the assumptions of these lectures are already uncertain. Can one, for instance, with increased numbers of teachers to supply, be quite certain that the entrants to the enlarged training colleges are going to be so much better than they have been in the last few years? Will sufficient well qualified staff be available to man the colleges? Many colleges have moved much further from the "lecture" pattern than is here supposed: it is our nomenclature rather than our practice that is out of date. We have also gone a long way towards making our colleges places in which students can become mature persons. Both these kinds of progress have only been possible because of devoted work by the staffs of colleges, so that the securing of an adequate staffing ratio, and a high proportion of resident staff to enrich and vary the character of the college community, is vital to the success of the three-year course. Neither of these issues is going to be won without a hard struggle. If we must choose between economising on the building programme and the teaching force, let us not make that common modern mistake and choose the buildings, but assert our belief in the value of our product, and vote for the human material first.

J. D. BROWNE

TECHNICAL EDUCATION

STEPHEN F. COTGROVE, *Technical Education and Social Change* (Allen & Unwin, London, 1958, 25s.).

THE history of technical education in England reflects at many points the changes in social structure which have taken place since 1824. To understand what is happening in the technical college of to-day we must take note of past history and past attitudes to education as well as present pressures.

Many conflicting ideas have played a part in the development of the technical college. The class structure, and aristocratic ideas about the education of a gentleman, to some extent explain the lower social status of institutions concerned both with workers' education and the teaching of technology.

The fact that much has nevertheless been done, though not quite enough, to educate the masses, is due in part to the ambivalence of the Christian philanthropists who were sure that the workers *should* be educated but could not believe it right that they should be encouraged to seek the highest status.

Without an appreciation of such factors we cannot understand why, for instance, the well-known Regent Street Polytechnic did not in fact qualify for consideration as one of the new colleges of advanced technology, or why the Lord President's Advisory Council on Scientific Policy has no member representing the technical colleges.

No social history of technical education, as such, exists; relevant facts and comment are buried in tomes dealing either with education in general or specific colleges in particular. To some extent the book under review fills this gap although the title does not suggest that this was the main intention. The title, in fact, raises expectations which the content, disappointingly, does not fulfil.

The first twelve chapters out of a total of thirteen cover the factual historical background of the technical colleges of this country. Dr Cotgrove has dealt faithfully with the literature and quotes not only from the historians but from many official reports and papers, a list of which fills nearly five pages of bibliography. Inevitably there are some errors which will seem more important to those in the colleges than to other readers. For example, the White Paper advocated eight to ten colleges of advanced technology, not twenty-four. Eight are already designated.

The book is negative in tone and also suffers, like some Royal Commission reports, from the disadvantages of hindsight. Emphasis is placed on the neglect of this and the failure of that rather than on the efforts of those struggling to improve the status quo. For example, the author deplores the fact, shown by the Acton Society survey and other studies, that very few of the managerial posts in British industry are occupied by science and technological graduates. The other side of this picture is that 50% of the managers in the Acton Society sample came up the "hard way" and this drive on the part of British workers to "better themselves" has been an important and positive aspect of our educational climate. The contrast between Dr Cotgrove's attitude and that of Lowndes in *The Silent Social Revolution* is very marked.

A questionnaire was used "to obtain additional information about students attending technical college courses". No copy of it is given but the nature of some of the questions can be gleaned from tables in Chapter 9. 882 replies were obtained from samples of students at Regent Street and Woolwich Polytechnics. The choice of these two colleges seems unfortunate even though the author is aware that they are untypical. Regent Street Polytechnic is a unique institution and the chemistry and engineering departments of Woolwich are recognised by London University for the award of internal degrees. Its status therefore is, in some ways, similar to that of a university college, so that questions relating to the students' choice of a technical college rather than a university throw little, if any, light on student attitudes to technical colleges in general.

After so much labour it is perhaps churlish to suggest that it is just at this point that the sociologist's work needs to begin. Reviewers are prone to tell authors that they have written the wrong book; in this case the reviewer will merely ask the editors, Ruth and David Glass, for a further volume on the subject of technical education in their series, *Studies in Society*. For these first 185 pages, though essential homework for the social historial, cannot in the nature of things be expected to reveal anything new to those intimately concerned with this work.

The last chapter of twenty pages, *The Technical Colleges and the Social Structure*, attempts to come to grips with the problem. Dr Cotgrove states that the purpose of his study is "to provide data relevant to policy". This data includes discussions on the linking of wages and salaries to qualifications, the introduction of more full-time training for technicians, the need to influence the status of scientific studies in schools, and the award of a degree to technical college students who reach degree standard. He is aware that such proposals "would be met with strong opposition". The fact is that such proposals have been and are being met with complete opposition. Trades unions will not reconsider wage structures in such terms, and the universities have successfully opposed the awarding of a degree for courses of study expressly stated to be of honours degree standard. This has resulted in cumbersome regulations which allow the technical colleges to have awards of their own but ensure at the same time that their status will be inferior to that of university degrees.

What we need from the sociologists is an examination of these resistances and the reasons why they are a particular affliction of the English educational scene. Why is it that the title "professor" is so sacrosanct only in England? Why is it possible for Zürich, Eindhoven and other continental cities to have technological institutions with university conditions, but so impossible for England? How is it that other countries manage to "afford" so much more full-time further education than we can?

It is not enough to document the facts and hope for rational reform. Panic measures have been taken at various times because of the fear of the industrial supremacy first of Germany and later of Russia. But they have never yet been whole-hearted. The threat subsides, forthright action can be avoided and only the fear of Technology remains. We have not yet learned that to deny status to those upon whom we depend for survival is dangerous and that the right motive for educational advance is not fear of foreigners but a concern for our own countrymen.

The data relevant to policy is there but the resistances are still winning. Can the sociologists help?

ETHEL C. VENABLES

MODERN DANCE

JOAN RUSSELL, *Modern Dance in Education* (Macdonald and Evans, London, 1958, 11s. 6d.).
JANE WINEARLS, *Modern Dance. The Jooss-Leeder Method* (Adam and Charles Black, London, 1958, 21s.).

MODERN dance has been firmly established in educational circles for a number of years but there are still certain misconceptions as to the meaning of this title. Some associate it with ballroom dancing, others conjure up vague and somewhat embarrassing visions of "expressive movement". This state of bewilderment may be partly due to the lack of printed matter available. Indeed the bulk of literature on this subject emanates from America where the title embraces a variety of approaches, whereas in this country modern dance is associated almost exclusively with the work of Rudolf Laban. These two publications should do much to spread knowledge and appreciation of this creative art; in addition both books should prove valuable sources of reference as they are designed to help the practising student and teacher of dance.

During recent years there has been a steady development of modern dance in schools and it has gained a particularly strong hold in girls' secondary schools, where it is generally recognised as a valuable contributory factor to all-round development. In this form of dance the child is encouraged to express ideas and observations in spontaneous and natural movement; thus scope is given for the imaginative capacity, sensitivity to music, and shape and dramatic feeling. This brings into play many aspects of the child's personality and although this subject is usually considered as part of the physical education programme, in many ways it has more in common with other arts subjects. Indeed Miss Russell suggests that "where there is close contact between those teaching the arts, there is great scope for co-operation". The growing emphasis on creative work in schools has provided the sort of climate in which this type of dancing can flourish. Although the need for "free dance" has been recognised in education in the past and opportunities have been given for this through various systems, it is only in recent years that this trend has been given direction by the wide acceptance of Laban's principles of movement. It is interesting to note that modern dance originated largely as a protest against the artificialities of classical ballet; this aspect was developed by Kurt Jooss and Sigurd Leeder with particular application to dance of the theatre. Another line of development was in educational circles where it had a liberating effect on dance work in schools. These separate lines of development are clearly illustrated by the two books reviewed. Both books show the influence of Rudolf Laban's work in the field of movement but differ in approach and content; each, however, makes a valuable contribution to education at a time when there is a need for clarifying both ideas and methods in dance.

Miss Russell's book is both comprehensive and explicit in nature. She deals with the wider implications of her subject and yet manages to focus upon details of eminently practical value such as suggestions for stimulating group composition, movement themes and dramatic ideas. The introductory chapter gives a general background of dance developments in this country and the author discusses certain aspects of dance in present-day education, putting modern dance into its wider setting. Miss Russell explains what is implied in the term "movement" and puts forward extensive claims for its potentiality as a means of education. This chapter, although mainly concerned with generalisations, touches on a number of controversial points as, for example, the educational value of other dance forms such as classical ballet, national dance and English folk dance. The author suggests that these may be of considerable value in certain respects but that they have limitations from an educational standpoint because they lack creative possibilities. Another controversial point is that "dance . . . brings with it knowledge of states of mind and inner drives and moods. The psychological effect of the work is important for we are making a definite impact and impression upon the inner life." This statement implies a deeper knowledge of psychology than the average teacher of dance possesses; it also implies a heavy responsibility which may present a somewhat alarming prospect to the young teacher as well as to the more experienced. While some may dispute these claims, there is no doubt that the statement of them will provoke useful discussion.

The generalisations in the introductory chapter are substantiated by careful analytical observations later in the book, and for the practising teacher and student of dance there is much useful material, assimilated from the author's own experience in education, in recreation and in systematic studies in this field. In the section on the content of the work Effort and Space are analysed simply and technical terms, which often cause alarm to the uninitiated, are clearly defined. The short glossary is also valuable for quick reference. It may be helpful to note here that the author, in defining terms, uses expressive language as befits her subject. There are also chapters dealing with the particular needs of primary and secondary school children and many will find these helpful in considering methods of approach and progression. For the head teacher or non-specialist, who is interested in the general educational value of modern dance and its inclusion in the curriculum, there is much food for thought, for example in the suggested possibilities of correlation with other arts subjects. Of particular interest is the chapter on dance for boys and men; here, as throughout the book, we are conscious of Miss Russell's practical experience of this work and the "typical programme of dance and dance drama", given at Worcester Training College by a mixed group of students, is evidence of the type of creative work which can develop in this sphere.

Many teachers find difficulty in getting the children to dance freely and spontaneously in the initial stages and Miss Russell suggests a number of stimuli which she has found useful in encouraging children to move naturally. These stimuli vary from the use of a variety of percussion instruments to the use of different visual arts, such as the children's own paintings or clay models of a three-dimensional nature. Many new and interesting ideas are set forth here by the author and she stresses that "in finding a wide variety of stimuli it is well to remember that children differ as to the sense which is strongest, and an appeal must be made to all. The sound, the visual picture, touch of texture or shapes, the mental image, the mood of movement; all should be used to give richness." In this context some readers might welcome greater stress on the importance of music and possibly a chapter devoted to this aspect, although the short appendix of suggested piano music and gramophone records should prove helpful to those who need guidance in choice of suitable music.

In attempting to clarify this creative art in print the author has set herself a difficult task, particularly since, as she herself emphasises, "we learn to talk by talking, to dance by dancing." The result is a stimulating and much needed publication which reflects her own infectious enthusiasm for her subject.

Modern Dance is another useful publication with a more technical approach. It is based on the Jooss-Leeder method and in this respect is the first text-book of its kind. Miss Winearls sets out to clarify a system rather than to discuss the educational and social value of creative dance; for this reason her book will be welcomed by teachers and professional dancers who require a more detailed analysis of movement and guidance in technique.

The author briefly outlines current styles and discusses the position of modern dance in this country as compared with America, Europe and Japan, where professional modern dance groups are given status and support. She also refers to the dance faculties which exist in certain universities and the opportunities for school teachers to continue their own dance education by performing with professionals. "In this way both the professional and educationalist are enriched," and indeed the professional dancer is accepted and recognised as a teacher in schools and colleges. The author touches on a problem of considerable significance in education when she alludes to the "wilderness between what is experienced by the child and student in Educational Modern Dance in school and college and what can be seen at top artistic level in the Theatre". Many schools arrange periodic visits to the ballet and undoubtedly these are of tremendous cultural value in many ways, but there seems to be very little link between this manifestation of expressive dance and the humble strivings of the child in school. Miss Winearls asserts that the Jooss-Leeder method has helped to bridge the gap between dance as an educational activity and dance as a fully matured art of the theatre. As this seems to be particularly relevant to the question of educating for post-school living it is worthy of consideration. This is not to suggest that all our geese should be expected to turn into swans, but there should be some closer relationship between the child's experience in school and her experience after leaving school.

The main content of the book is a detailed analysis of the principles of movement, technique, dynamics, direction and design. The analysis is elucidated further by Peter Krummins' drawings and by useful diagrams. Although, as always with an expressive art, the setting down of certain laws is likely to provoke discussion, a careful formulation of the Jooss-Leeder method is of undeniable value as this system has been tried and tested for nearly thirty years. Many teachers will find it useful not only in crystallising fundamental principles but also in providing a basis for disciplined training with a view to higher standards of performance. The author indeed lays emphasis on the need for training and discipline in any art form and deplores the amount of formless self-expression which abounds; she asserts that the arts should also be a clearly articulated means of communication. Some exponents of modern dance may criticise the apparent rigidity of the training methods advocated, but it is clearly established that the classification and examples given should be used by the individual in her own way. "Creative improvisation and composition implies more than mastery of technique." The aim is to educate the person whilst training the dancer. Herein lies the added contribution of this publication, for it not only sets down a method clearly in print, but carries us beyond to the wider possibilities of using this method as a stepping-stone to artistic achievement.

C. D. Roberts

Vernon Mallinson, *An Introduction to the Study of Comparative Education* (Heinemann, London, 1957, 21s.).

With the object of providing "a conspectus of the contemporary scene in matters of educational policy and practice in Western Europe", the author examines education in Belgium, England, France, Germany, Holland, Italy, Scandinavia and Switzerland in the light of what he finds to be the national characters of the countries concerned. He seeks the reasons for and discusses the outcomes of different approaches to common problems and includes comparative studies of the U.S.A. and the U.S.S.R. in his survey.

In his approach to the particular aspects reviewed, the author discusses the nature of comparative education in the setting of general educational purposes; the ways in which the national character of particular countries determines their educational policy and organisation; and the factors—geographical, economic, historical, religious, political and social—which have determined their national characters. A discussion follows on trends in the development of progressive educational ideas in which, among others, Rousseau and Dalcroze, Dewey and Kerschensteiner, Montessori and Decroly come under survey.

In this context, the remaining two-thirds of the book are devoted to studies of the aims and administration of education, the training of teachers, and primary, secondary, technical and vocational education in the countries under review.

Diagrams to illustrate the organisation of education in seven of the countries are appended and there is a short representative bibliography.

B. C. L. JAMES

J. T. GOINS, *Visual Perceptual Abilities and Early Reading Progress.*
W. M. O'NEIL, *An Introduction to Method in Psychology.*

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LIBERAL EDUCATION TO-DAY

by M. V. C. JEFFREYS
Professor of Education and Director of the Institute of Education, University of Birmingham

1. LIBERAL EDUCATION AND THE HUMANITIES

THE association—if not the identification—of liberal education with the humanities is traditional in universities and grammar schools. Indeed, it has often been assumed that the way to "liberalise" a scientific or technological curriculum is to inject into it some doses of literature, history, or other Arts subjects. If these ingredients remain distinct and unabsorbed, like plums in a cake, that has not necessarily been thought to impair their redemptive value.

For centuries the humanities virtually monopolised the universities and grammar schools, and for a century (up to the second World War) they held pride of place. Now their prestige is threatened. Almost overnight—or so it seems—the faculties of Arts have been upset from an assured position into a precarious predicament.

The threat to the prestige of the Arts faculties has come, of course, from science and technology. The need for scientific manpower exerts an irresistible pressure on the educational system. Stimulated by the highly technical character of the war itself, and by the keen industrial competition since the war, the study of science and technology has flourished exceedingly in the last twelve years. In the universities, the number of science and technology students has increased 124% since 1938-39, and in 1956 represented 34½% instead of 26% of the whole university population. On top of that, we are now embarked on a planned programme of expansion during 1956-62, costing £70 million. Technologists are to be produced by universities and by technical colleges—especially by the twenty-four colleges of advanced technology foreshadowed in the Percy Report of 1945 and now in existence.

It is not surprising that the Arts faculties view this expansion with some anxiety—anxiety about their own status and future, and also about that rather nebulous thing called the "general balance of education". Various attempts have been made—from the common first year of general studies at Keele to the weekly lectures in the University of Birmingham—to keep the flag of liberal education flying.

Liberal education certainly is threatened in the world of to-day. But I want to suggest that a simple identification of this threat with the growth of technology is a wholly inadequate analysis of the problem. There are other influences more menacing to liberal education than technology, however narrowly conceived. Nor is technology necessarily illiberal; to assume that it is would be to prejudge the issue and throw the whole discussion into a false perspective.

2. What is Liberal Education?

Before examining the influences that threaten liberal education to-day, we ought to say what we mean by liberal education.

Max Parrish, in *Liberal Education in a Technical Age* (1955), says: "We regard a liberal education as one which includes a training in the use of language, in the handling of ideas, in recognising relationships, and establishing values as touchstones by which questions of taste and morals are to be decided." In this passage he emphasises the feature which has always been held to distinguish liberal education, namely that it not only conveys certain information or trains certain skills, but also promotes an understanding of causes, purposes, and all that lies behind the practical situations of life. This is what Matthew Arnold meant when he said: "The ideal of a general liberal training is to carry us to a knowledge of ourselves and the world." Education is liberal in proportion as it helps us to understand life by seeing it whole and in proportion.

The late Mr R. F. Young wrote what is still a minor classic in the form of a note on the development of the idea of liberal education, which appeared modestly as Appendix II of the Spens Report of 1938. In it he reminds us that the conception of liberal education is at least as old as Plato. And, though the classical Greek definitions of liberal education (contrasting, as they do, the education suitable for freemen and the education fit for slaves) are hardly acceptable to the modern democratic temper—any more than they would have been to the Hebrews of the ancient world—it is as well to remind ourselves that the education which Plato and Aristotle wanted freemen to have was one that gave them a background understanding of life as well as competence in specific activities. In short, for Plato and Aristotle, education was not liberal unless it engendered a philosophy of life.

It is also worth reminding ourselves (especially in view of the modern tendency to identify liberal education with the humanities) that the seven liberal arts, as they became stereotyped in the Alexandrian period, were grammar, music, geometry, arithmetic, astronomy, and certain aspects of rhetoric and dialectic. Of these Seven Pillars of the House of Wisdom, astronomy belongs to the faculty of Science and mathematics belong to both Science and Arts.

Not only must we dismiss, as fallacious, the notion that Arts faculties can claim a monopoly of liberal education, but we must also dispose of a false antithesis between liberal and vocational education. Although Aristotle excluded from the education of freemen those pursuits which he stigmatised as banausic ("garage")—pursuits which unfit the body, soul and intellect for the exercise of virtue—we must not forget that the education of the Athenian citizen was thoroughly vocational in the sense that it was designed to fit him for his political and military duties. So, for that matter, was the education of the eighteenth-century English gentleman.

The best education, indeed, is both liberal and vocational. The three disciplines that dominated the universities for centuries—theology, law and medicine—are good education for precisely that reason: they deepen the student's understanding of people and the world, and also equip him for a job.

I do not deny that education can be vocational only, in the sense that it inculcates skills without a broad and deep background of understanding: in the words of a nineteenth-century writer quoted by R. F. Young, it "is careful not for the worker but for the work".

Equally, education can be liberal only, in the sense that it cultivates a general interest in men and affairs without coming to the point of practical competence in any particular field; such education may be ornamental but, so far from being merely useful, it may not even be usable.

In an often quoted passage Professor A. N. Whitehead wrote: "The antithesis between a technical and a liberal education is fallacious. There can be no adequate technical education which is not liberal, and no liberal education which is not technical: that is, no education which does not impart both technique and intellectual vision. In simpler language, education should turn out the pupil with something he knows well and something he can do well. This intimate union of practice and theory aids both. The intellect does not work best in a vacuum." In other words, if knowledge is to release power, it must do two things. It must open the temple of Wisdom. And it must support skill. Although knowledge should not be merely useful, it must be usable. We are in the world to *live*, not only to contemplate.

Finally, at the level of curriculum, the way to make education liberal is not to introduce a modest proportion of literary studies into a programme of applied science, hoping thereby to civilise the technician. An interesting report on *The Liberal Aspect of Technical Education* (1956) published by the Yorkshire Council for Further Education has this passage: "The introduction of 'arts' subjects into curricula of science and technology is not fundamental to a liberal education. What is required is a broadening of the treatment and presentation. This ought to be adapted to the age and interests of the students. The approach may be through the history of the craft, a study of the structure of the industry, the philosophy of the subject, human relations in industry, or talks and discussions on industrial design." That is to say, science and applied science can be as effective vehicles of liberal education as the humanities provided they are studied in such a way as to reveal their human and philosophical implications.

This does not mean, however, that technical education is automatically humanising. Technology may in principle be inseparable from humanism; but it can easily fall apart from humanism unless steps are taken to prevent the separation. A recent reviewer of Sir Eric Ashby's *Technology and the Academics* (in which is outlined a course in the humanities for inclusion in higher technological education) comments: "Dentists are up to other people's necks in human problems, but they are not for that reason humanists."

3. INFLUENCES THREATENING LIBERAL EDUCATION

If we try to account for the predicament in which liberal education finds itself to-day, we can distinguish three main evils.

(*a*) The greatly increased academic pressure on those who aspire to higher education. In all subjects, as the frontiers of knowledge are extended, there is more to be learnt, and by and large there is no more time in which to learn it. Not only that: but, in the name of democracy and educational opportunity, public money is poured into education on an unprecedented scale, and examination standards (by which the successful candidates are expected to justify their receipt of public money) are pushed up and up. The results are overcrowded curricula, mental indigestion, and the inculcation of an attitude which sees higher education in terms rather of swallowing and regurgitating knowledge than of promoting thought and cultivating taste. If yo have to do a four-minute mile, you can't stop to admire the view an pick flowers. It is true you can slack. But slacking is a very differen thing from browsing; and the truth is that the modern university, an the modern grammar school for that matter, afford little opportunit for intelligent and profitable browsing.

(*b*) Then there is the peculiar predicament of the Arts faculties which are in danger of suffering the fate of the dodo. Although th Arts faculties can claim no monopoly of liberal education, they ar responsible for those humane studies—history, literature, philosophy, language—which ensure that the essentials of liberal education ar not forgotten. To this extent the future of liberal education is bound up with the future of the faculties of Arts.

Now the Arts faculties, which have not expanded to the same extent as the science faculties since the war, have lost—and will continue to lose—relative importance and influence. There is also the awkward question which, in the interests of self-preservation, faculties of Arts must try to answer—namely what is to be their real function in the world of to-morrow, apart from producing teachers to produce more Arts students. (I know that a good many Arts graduates go into business and other occupations, but hardly in sufficient numbers to keep the Arts faculties prosperous.) If it is true, as I suggested earlier, that education ought not to be merely ornamental, then the Arts faculties must answer the question of their future in terms of usefulness.

To be healthy, a faculty of Arts ought to be in living relation with the world outside, as is the case with science, both pure and applied. There is no doubt about the value and status of disciplines which at one and the same time give a vocational training and a liberal education of the person, as Theology, Law and Medicine have done for centuries. This principle is surely capable of extension. University studies on the Arts side could function as a power-house supplying knowledge and ideas in the way that the Science faculties serve the world of industry and government. It is a weakness of the Arts faculties that the outside world does not turn to them as it does to the Science faculties, and—perhaps even more significantly—that the Arts faculties show little interest in "selling themselves" to the outside world. It may be a sufficient justification of intellectual activity to say that its purpose is the pursuit of truth, if that phrase simply means that we ought never to pursue what is not true. But there is no value in pursuing knowledge, however true, which is not usable or likely to be usable. The Arts faculties have got to justify themselves in a much more practical way, to the government on which they depend for money, and to the public on which they depend to buy their products.

Now there is a certain practical connexion between English schools and the theatre, for the theatre (having been with us for centuries) is academically respectable. But, on the one hand, this connexion could be stronger; the universities could have flourishing schools of drama. And, on the other hand, the cinema and the radio are not yet academically respectable, and consequently the universities exert scarcely any influence at all on these forms of public entertainment. These instances are given only as illustrations, and it would be necessary, for example, to think out ways of making the study of languages more effective as an instrument of practical living. There seems to be no intrinsic reason why the work of the Arts departments should not be geared to a variety of occupations as is most of the work in a faculty of Commerce or Social Science.

C. S. Lewis wrote recently: "... the Intelligentsia (scientists apart) are losing all touch with, and all influence over, nearly the whole human race. Our most esteemed poets and critics are read by our most esteemed critics and poets (who don't usually like them much) and nobody else takes any notice." The universities can have no more important task than to do something about this failure of communication and interpretation.

(*c*) This comment by C. S. Lewis on the gulf between the intelligentsia and the general public leads us to the third of the evils which threaten liberal education. The first was the excessive academic pressure throughout higher education. The second was the ivory-tower detachment of most of the Arts subjects from the practical life of the world around. The third, which affects the national life as a whole, is the discrepancy between relatively high economic standards and relatively low cultural standards. The purchasing power of the great mass of people has increased much more rapidly than their education, with the result that they can have a great many more things than they know how to appreciate. From this point of view there may be something to be said for the policy of the U.S.S.R. in limiting the availability of consumer goods.

One of the consequences of supplying a semi-educated people with almost unlimited supplies of consumer goods (including the various forms of cheap, standardised entertainment) is the creation of an attitude of mind which is not only uncritical but inactive—

accepting passivity and vicarious experience in preference to active participation.

Richard Hoggart, in *The Uses of Literacy*, speaks of a "faceless culture" and says: "We are in a pallid half-light of the emotions", in which there is no sincere challenge. There is, of course, another side to the coin. Since, as Plato said, every extreme provokes its opposite, the "candy-floss world" has, as its ugly counterpart, the world of violence and brutality—in which we may perhaps detect a pathological assertion of the need for activity and participation. Sex has its place in both these worlds. On the one hand there are the pasteurised pin-ups, and on the other the beastly literature of sex violence. It is the unreality, the lack of integrity, of this culture which is a denial and evasion of the best that the tradition of liberal education stands for. There can be no greater mistake than to suppose that liberal education means that everyone must be intellectual. May I quote Richard Hoggart once more: "To wish that a majority of the population will ever read *The Times* is to wish that human beings were constitutionally different, and is to fall into an intellectual snobbery. The ability to read the decent weeklies is not a *sine qua non* of the good life. It seems unlikely at any time, and is certainly not likely in any period which those of us now alive are likely to know, that a majority in any class will have strongly intellectual pursuits. There are other ways of being in the truth. The strongest objection to the more trivial popular entertainments is not that they prevent their readers from becoming highbrow, but that they make it harder for people without an intellectual bent to become wise in their own way."

4. WHAT CAN BE DONE ABOUT IT

The education available in any community is an integral part of the life of that community and a complex product of its history and culture. As with government so with education. There is a sense in which a country gets the education it deserves, and an educational system cannot be reformed, as it were, from the outside, by forces that do not themselves grow out of the traditions and attitudes of the people whose educational system it is.

There is in fact a circular relation between the culture of a community and that community's education. Plato recognised this relation by acknowledging that, while the perfect state is impossible without a perfect system of education, a perfect system of education can exist only in the perfect state.

In short, we must remember that educational reform is always limited by conditions which may themselves be largely responsible for the need of reform. That, however, does not mean that nothing can ever be done to improve matters. I should like to suggest some lines of action that might help the cause of liberal education at the present time.

(*a*) *The humanities and the outside world*

Attention has already been drawn to the unfortunate separation of the academic study of the humanities from the practical life of the world around. If the Arts faculties want to keep themselves healthy, they must do more than they are doing now to explain themselves to the general public and to relate their activities to the needs of the general public. I am not suggesting that this double task would be an easy one. But it offers a very worthwhile field of investigation and experiment.

(*b*) *Development of deferred training*

It is generally recognised that courses leading to the first degree, especially on the science side, are overcrowded, and that, as a consequence, some of the pressure is pushed back into the grammar school, which is expected to anticipate at least the first year of what used to be regarded as university work.

This pressure on the first degree course, and on the grammar school, is against the interests of liberal education inasmuch as it tends to keep the student's eyes on the road and discourages the contemplation of broad horizons. There are two ways in which the pressure could be relieved.

In the first place, the course leading to the first degree could be lengthened from three years to four. There is a certain amount of support for this change, and the University College of North Staffordshire affords a notable example of bold experiment in this direction. It is very doubtful, however, whether a lengthening of the degree course is really the answer to the problem. Young people grow up sooner than they used to; they marry earlier; and they want to be out in jobs. Moreover, there is little doubt that a certain price is inevitably paid for extended full-time education. That price is a postponement of personal and social maturity; the grammar school boy of 16 is less worldly-wise than his opposite number who left school at 15, and the boarding-school boy less than his contemporary at the day school. Admittedly the worldly wisdom of the ex-secondary modern pupil is not always very attractive. But that hardly affects the case against artificially postponing adult status by prolonging full-time higher education.

The other way of relieving the pressure on the degree course is gradually to develop a far more elaborate programme of deferred training than exists at present. If some kind of further study, after a period of employment, came to be thought of as normal for graduates, it would then be possible to regard the first degree, not as completing a university education, but as an introduction to further study. This kind of development would need more generous provision for secondment on pay than is yet available. But all the indications are that this is the true line of development. Already much has been done since the war (especially in technology and notably in the sandwich courses) to blaze the trail. There is this further advantage in deferred training: that mature students with a few years experience in some trade or profession get far more benefit from a course of study than inexperienced students can get from the same or a similar course.

(*c*) *Adult Education*

I referred earlier to Richard Hoggart's *The Uses of Literacy*, and quoted some passages from that book on the unreality of a good deal of modern entertainment. If we are thinking of the culture of the general public, we are bound to hope for a great development of adult education of all kinds, ranging from the formal classes run by the W.E.A. or University Extra-Mural Departments to the informal activities of Women's Institutes and dramatic clubs. The best way to fortify people against the enervating effects on morale of passive entertainment, or the numbing effects of the more physically active rhythmic rituals, is to get them interested in doing things for themselves, especially things that involve some intelligent team work. In this connexion we must recognise three values—the value of the activity itself, be it photography or drama; the value of voluntary initiative within the rather paralysing architecture of the Welfare State (the areas in which people can originate and carry out activities entirely their own become increasingly precious); and the value of practice in organisation and administration which quite large numbers of people can gain through these activities.

We must, moreover, avoid the mistake of trying to make adult education in general an inferior copy of the university, or of expecting average men and women to be intelligent about public affairs or learned matters at a high level. Every society produces an élite of some kind and, when it comes to the more demanding intellectual tasks, the main job of the ordinary citizen is to choose leaders who can be trusted.

The foundation of healthy life in any society will always be the worthwhile activities of ordinary folks, whose scale of operations is the neighbourhood rather than the national state, or even the city. The quality of national life, and the national morale, are rooted in the rabbit-club, the gardening club, the local dramatic society, the Women's Institutes, the W.E.A. classes, and the hundreds of neighbourhood activities, including those connected with the churches, all of which provide good social and personal education.

On whatever scale people operate—modest or imposing—the vital thing is that they should operate as persons—that they should take responsibility for their own opinions and behaviour, and that relations between people should be kept personal and not allowed to become impersonal. At bottom education, and everything worthwhile in civilisation, is the influence of persons on one another.

The greatest danger to our world is the threat to personal values. That is the danger of the "faceless culture" of which Richard Hoggart speaks, and is only another way of describing the threat to liberal education, for, if liberal education is concerned with one value above all others it is the value of human beings as such and of their relations with one another.

If this generation were to blow itself up, it would be too bad. But it would be worse if, in our preoccupation with defence against the nuclear peril, we let the pass be sold spiritually behind our backs. It would be worse if, by dying on our feet, technologists and all, we incurred the epitaph: "This generation gained the whole world and lost its own soul."

THE STATUS OF THE TEACHER IN ENGLAND AND WALES

by E. G. PEIRSON
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PART I: HISTORICAL BACKGROUND

THE future of any nation in this highly competitive, technological age depends in the last resort on the adequacy of its educational system. In its social aspect, education is "the means by which a nation organises its human ability for the purposes of every form of national effort". It is also "the instrument by which a nation transforms itself from what it is into what it hopes to be" (1). It is a matter of simple self-interest for a nation to devote a large proportion of its resources to the education of its people and if it fails to do so it must sooner or later decay.

At the centre of the educational process is the personal relationship between teacher and pupil; it follows, therefore, that it is the quality of individual teachers that determines the effectiveness of the educational system, which can be no better than the teachers can make it. The point was emphasised by that most human yet shrewd Minister of Education, the late George Tomlinson, who at the 1947 conference of the National Union of Teachers said: "The teacher is the vital link. At a pinch you might be able to do without parliament. You could do without the Minister: you could certainly do without civil servants and almost as certainly without local education authorities. But if there were no teachers the world would be back in barbarism within two generations."

Now the teaching profession must compete for its recruits against an ever-increasing number of other professions, many of which offer great opportunities in terms of salary and status; it will not attract people of the quality needed unless its prestige is high and individual teachers are respected and honoured as important members of the society they serve. In a very real sense the future of a nation is linked with the status it gives to its teachers.

We are better able to appreciate the status of the teacher in our own society to-day if we first review briefly the changes in status which have occurred during the past 150 years.

The teaching profession had its origin in efforts made to provide education for working-class children in the early years of last century. The schools then established had very restricted aims: to give instruction in the elementary skills of reading, writing and arithmetic. It was assumed that these elementary skills could be taught by anyone who had some little competence in them himself, and, since the salaries offered were ludicrously small, only those who had proved to be incompetent in other walks of life were willing to undertake the task.

The low regard in which the teacher was held in the first decades of the nineteenth century is made clear in the following quotation from a report by Sir James Kay-Shuttleworth, the first Secretary to the Committee of Council set up in 1839 to administer state grants for education:

"There is little or nothing in the profession of an elementary schoolmaster in this country to tempt a man having a respectable acquaintance with the elements of even humble learning to exchange the certainty of a respectable livelihood in a subordinate position in trade or commerce for the mean drudgery of instructing the rude children of the poor in an elementary school (2)."

Or one can quote Lord Macaulay's well-known description of teachers as "the refuse of all other callings, discarded footmen, ruined pedlars, men who cannot work a sum in the rule of three, men who do not know whether the earth is a sphere or a cube, men who do not know whether Jerusalem is in Asia or America. And to such men, men to whom none of us would entrust the key of his cellar, we have entrusted the mind of the rising generation, and with the mind of the rising generation, the freedom, the happiness, the glory of our country (3)."

Kay-Shuttleworth quickly realised that no educational advance was possible without an improvement in the quality of the teachers and, through his introduction of the pupil-teacher system and support for the establishment of training colleges, he helped to raise their status from that of unskilled workers to that of skilled craftsmen.

Under the pupil-teacher system, the most gifted pupils in the elementary schools were indentured as apprentices to experienced teachers at the age of thirteen for five years. After completing this period they took a competitive examination for entry to a training college for a two-year course. This course was, however, narrowly conceived and included little opportunity for the students to achieve a higher level of personal education. Indeed, when Derwent

Coleridge, the Principal of St. Mark's Training College, Chelsea, attempted to extend the academic content of the curriculum he was accused of educating the students above their station instead of training them for service as teachers in elementary schools (4).

Nevertheless despite this kind of opposition improvements were made in the training college curriculum during the last decades of the century and, as the educational background of the teachers improved, so did the esteem with which they were regarded. Important, too, were the steps taken by the teachers themselves to build up a higher status by joint action. In the year 1870, famous for the passing of the first Education Act, the National Union of Elementary Teachers was founded (later to change its name to the National Union of Teachers) and this body quickly proved itself a powerful force for the improvement of the teachers' status (5).

By the end of the century progress had been such that it was possible for a writer in the *Fortnightly Review* to say of the elementary school teacher: "He is a small middle-class person with all the usual intellectual restrictions of his class. He is, in other words, unintellectual, knowing hardly anything well, parochial in sympathies, vulgar in the accent and style of his talking, with a low standard of manners. He is withal extremely respectable, correct morally, with a high sense of duty, as he understands it, and competent in the technique of his calling (6)." Not a very flattering description but a marked advance on "the refuse of all other callings".

The last fifty years has seen great progress, much of which stems from the great Education Act of 1902. By placing the responsibility for education in the hands of county and county-borough councils, Balfour's government showed that education had become a social service of primary importance and this raised at once the prestige of the schools and those who worked in them. But of even greater importance were the provision made for the establishment of secondary schools and the arrangements made in 1907 for abler pupils in the elementary schools to be transferred to these schools at the age of eleven. This led to the recruitment of pupil-teachers from secondary schools and eventually to the abolition of the pupil-teacher system altogether after arrangements had been made for boys and girls to stay on at school to the age of eighteen before entering the training college direct. These boys and girls, who had enjoyed the advantage of a more liberal and scholarly education in contact with teachers who were university graduates, had a better academic background than the old pupil-teachers, and the training colleges were able to build on this to produce teachers who were not only competent in the classroom but who also had real knowledge of and love for their subjects.

The introduction of secondary education also brought into the teaching field large numbers of graduates, many of considerable scholarship. Not that they regarded themselves as belonging to the same profession as the elementary school teachers; neither were they regarded as such by public opinion. They attracted to themselves the high prestige which has always been given to those of academic distinction and we must recognise that they formed an entirely separate profession until the passing of the Education Act of 1944.

The Board of Education showed its appreciation of the improved quality of teachers by gradually relaxing the direct control of the teachers' work which it exercised through regulation and inspection. In 1902 the elementary schools were governed by the Elementary School Code, a document of seventy-six pages which specified in detail the work to be done in each of the standards into which the school was divided. By 1926 this document had been reduced to a mere pamphlet of ten pages, which gave only very general guidance concerning curriculum and syllabuses and which the majority of teachers never saw.

A further significant change was the abdication of the central authority from its responsibility for training and examining teachers. Until 1926 a teacher's qualifying certificate was awarded by the Board of Education after an examination set and marked by its own officers. In 1926 the conduct of the examination was delegated to regional boards which included representatives of the universities and the training colleges themselves. Thus, for the first time, the colleges were required to accept some responsibility for setting their own standards; at the same time the change marked the first direct contact between the training colleges and the universities and paved the way for the more intimate association brought about by the setting up of university institutes of education some ten years ago.

The cumulative effect of these and other changes, together with a growing appreciation of the importance of an efficient education system to the nation's well-being, was to raise the status of the teachers in the eyes of the public. There were more favourable references to the profession in the press and men of substance in all walks of life urged the importance of the teachers' contribution to national life. For example, Sir Charles Wakefield, Lord Mayor of London, reviewing the opportunities open to young people about to leave school, described the teaching profession as "a form of social service, a high and noble calling that is an essential factor in the upbuilding of national character, through which, very largely, British ideals of conduct and morals are transmitted from generation to generation. Approached in this light, the profession is among the most arduous and responsible of all (7)."

The passing of the Education Act of 1944 marks the next major advance. Firstly, its administrative changes, including the setting up of a Ministry of Education, established the education service as a national concern of primary importance. Secondly, it swept away the division of education into elementary for the majority and secondary for the chosen few, and replaced this unhappy dichotomy by a unified system which must be followed sooner or later by a unification and consolidation of the teaching profession itself.

One further significant development must be noted—the setting up of university institutes of education. This has not only raised the status of the training colleges by bringing them into the university family but has also led to the most fruitful co-operation between university and trainingcollege lecturers in the important task of raising the academic standards of non-graduate entrants to the profession. The introduction of the three-year course in 1960 will carry us a further step towards the ultimate goal of all concerned for the quality of the education service—graduate status for all teachers and full recognition of their standing as a professional group.

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THE TEACHING OF ARITHMETIC

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PART I: THE CHANGING OUTLOOK (1)

> Rarely is a teacher satisfied with the arithmetic of his class. He is not allowed to be. Somebody always has something to say about it—generally something unpleasant. If it is not a colleague, it is an Inspector . . .
>
> P. B. BALLARD, 1928 (2).

THE voice of dissatisfaction is never long silent in respect of school arithmetic. The method of its teaching is constantly called into question. We are now told that faulty attitudes towards mathematics are often set up in the primary schools and the teaching of arithmetic there is in large measure responsible for the present dearth of mathematicians, scientists and technologists. In a recent article to this journal, Mr J. S. Flavell refers to the "blind performance of little-understood processes such as comprise a large part of junior school arithmetic to-day"; he suggests that in overemphasising computation at the expense of understanding, teaching methods used in recent years "have tended to create dislike, even boredom and frustration, in many students (3)". An attempt is made in the present article to consider further the teaching of arithmetic both in the light of its historical development and in relation to the nature of the subject.

The Hindu-Arabic number system was introduced into Europe during the twelfth century and was coming into general use in this country during the sixteenth and seventeenth centuries. Older methods of reckoning and recording tended to persist and, as is well known, the Treasury continued to use the tally until 1826. By founders' statutes, the older grammar schools were obliged to follow a classical course and arithmetic was generally excluded from the curriculum until the nineteenth century (4). At Harrow, for example, arithmetic was introduced as a voluntary subject in 1819, becoming compulsory in 1837 (5). At Eton, it remained an "extra", on a par with dancing and fencing, until 1851 (6).

Details of the extent and quality of the teaching of arithmetic and mathematics in the endowed and private schools are given in the Schools Inquiry Report (Taunton Commissioners) which was issued in 1868. It appears that the traditional classical course occasioned much dissatisfaction amongst parents whose sons were not intending to proceed to a university (7) and there existed a widespread demand for instruction in arithmetic and elementary mathematics. The Commissioners were fully convinced of the indispensability of arithmetic. "Both for its utility and its educational power, nothing else can stand in its place," they wrote. "It has not, of course, the breadth which belongs to the study of language, but it has still greater power of exercising the reasoning faculties, and it is the gateway not only to all natural science, but to a very large part of men's dealings with each other (8)."

Arithmetic was being taught in most schools by this time but the teaching was usually far from satisfactory. "The time spent in the working of arithmetic appears to me to be wholly disproportionate to any result either intellectual or practical which is achieved in the majority of the schools. A large part of every day is spent in what is technically called 'cyphering' or 'doing sums'. Each boy is required to work out a number of problems, and at certain intervals to show that he has obtained the right answer. How he does the sum, whether he understands the process, or associates any definite idea at all with the figures which fill his slate are questions which seldom occur," wrote the Commissioner for the Northern Counties (9). Results for schools in the Southern Counties were highly commended but at the same time "it often happened that the most lamentable ignorance was shown by boys in the lower part of the schools of the principles of what they did. Boys, too, were doing fractions and decimals and were repeatedly puzzled when I asked them to explain familiarly to me the meaning of $\frac{12}{13}$ of a loaf, or how many, in a school of 40, ·5 represented. They were apt to regard the figures as mysterious cabalistic signs, with fixed laws and rules which had to be committed to memory but had no bearing on practical life. . . . I think that the reason of things was unduly and unnecessarily neglected (10)." Teachers evidently required only correct answers from their pupils, who committed rules and processes to memory and attempted to apply them mechanically with little or no understanding of underlying principles.

Mathematics was also valued by the Commissioners (11) but they considered the teaching to be rarely satisfactory. They frequently referred to the teachers' lack of interest and mathematical knowledge, and to the shortage of equipment in the schools (12). The work attempted rarely went beyond the beginnings of Euclid and algebra; some trignometry was occasionally included. Summarised extracts of reports on some individual Yorkshire schools are given below (13).

Text-books of the day shed an interesting light on the methods of teaching arithmetic. In one of these, written by James Trotter of the Scottish Naval and Military Academy and published in 1853, the treatment of compound subtraction, for example, appears as follows:

> Compound Subtraction is the method of finding the difference of two numbers, expressed in several denominations.
>
> Rule. Place the less number under the greater, so that numbers of the same denomination shall stand directly under each other. Begin with the lowest denomination, substract the number in the lower line from that above it, when it is not greater than the upper number, and place the remainder below. When the lower number is greater than that above it, as many units must be added to the upper number as make one in the next higher denomination before subtracting; then carry one to the next higher denomination in the under line, with which proceed in the same way until you come to the highest, when the operation is the same as in Simple Subtraction.
>
> Instead of adding as here directed, it will be easier in practice to take the under number from the number of units which make one of the next higher denomination, and afterwards add the remainder to the upper number.
>
> The method of proof is the same as in Simple Subtraction.

£147 18s. 2¾d. is taken away from £715 13s. 4½d. to illustrate the working of the rule and a set of thirty-eight examples follow, the first being

£314 10s. 7¼.
£118 13s. 4½d.

A selection from the 3,400 "new Exercises" provided by the author is as follows:

1. Required the cube root of 926574216749.
2. If a salmon leaves Berwick at 7 o'clock on Saturday night, and swims uniformly 8 miles an hour, including all obstructions; when will he pass under the bridge at Peebles, supposing the distance by water 69 miles?
3. How many times would you require to place Arthur's Seat (821 feet high) upon the top of Goat Fell (2865 feet high) to reach the height of Kunchin-ganga (28,177 feet high)?
4. How many metres in a degree of the meridian in lat. 44°|51′|2.5″ N. where an arc of 12°|22′|12·7″ measured 4509832 feet? (Ans. 111119·671788 metres)
5. The whole area of France is 52,966,030 hectares; express this in English acres and square miles, the hectare being equal to 2.473614 acres. (Ans. 131,017,513·33242 acres; 204714·864582 square miles)

6. A and B can do a piece of work in 3·5 days, A and C in 4·48 days, and B and C in 5·2 days; find in decimals the part done by the three together and also by each in one day.
(Ans. Together, $.35061\dot{8}1318\dot{6}$; A, $.15831\dot{0}4395\dot{6}$; B, $.12740\dot{3}8461\dot{5}$; C, $.16490\dot{3}8461\dot{5}$)

7. Find the value of £10,000 ÷ $\left(\dfrac{\frac{2}{3}+\frac{4}{9} \text{ of } 6}{\frac{2}{3}(\frac{5}{7}+\frac{6}{11})}+\dfrac{2\frac{7}{9}-1\frac{1}{2}}{\frac{4}{7} \text{ of } 5\frac{2}{3}}\right)-\text{£}\,\dfrac{\frac{1}{3}(\frac{7}{16}+\frac{11}{12})}{\frac{3}{8}(\frac{2}{7}+\frac{3}{4})}$

Ans. £2290 $\dfrac{65115940}{135221751}$

8. What number added to $\frac{3}{11}$ of $\frac{5}{16}$ of $\dfrac{\frac{7}{11}}{\frac{4}{13}}$ will give for the sum $\frac{7}{13}$ of $5\frac{1}{2}$?

Ans. $2\dfrac{79055}{100672}$

The chief aim of the author was stated in the Preface as being not to teach "the mechanical part of the science only, but real Arithmetic, by framing the Exercises in such a manner as to lead the pupil to reason upon the matter, and thus to beome a self-instructor". He endeavoured to make his exercises "applicable to the business of real life" and "to avoid puerility and abstruseness" in their compilation!

An Arithmetic rather more moderate in its demands and which achieved wide popularity was that by J. W. Colenso, Mathematics Master at Harrow for a brief period from 1839 and a later Bishop of Natal; the book was first published in 1843. The 1862 edition (15) devoted only seven pages to notation, numeration and the four rules in number; trillions and quadrillions appear on the first page. Tables of Money, Weight (Avoirdupois, Troy, Apothecaries'), Length, Area, Volume, Capacity, Time and the Calendar are given in great detail, the one for Length appearing as follows:

4 Inches = 1 Hand
12 Inches = 1 Foot
3 Feet = 1 Yard
6 Feet = 1 Fathom
5½ Yards = 1 Rod, Pole or Perch
40 Poles (220 yards) = 1 Furlong
8 Furlongs (1760 yards) = 1 Mile
3 Miles = 1 League

$$\left.\begin{array}{l}2\tfrac{1}{4}\text{ Inches} = 1\text{ Nail}\\ 4\text{ Nails} = 1\text{ Quarter}\\ 5\text{ Quarters} = 1\text{ Ell}\end{array}\right\}\begin{array}{c}\text{Cloth}\\ \text{Measure}\end{array}$$

Explanations and rules for reduction occupy three pages and a set of sixty examples follows, employing all the tables. Area receives but two and a half pages; volume one and a half, and of the seventeen pages given over to decimals, six are concerned with recurring decimals.

Both books develop the subject clearly and logically and their style is much in advance of older text-books. The treatment is based on logical rather than psychological considerations and is consistently formal and academic. It ignores utilitarian and practical values, employs large numbers, makes no attempt at approximations, and concentrates exclusively on rules and processes, applying them to problems artificial in type and far removed from everyday experience.

An arithmetic paper set in the Exhibition Examination for entrance to the Wyggeston Boys' School, Leicester, in 1882 (candidates would be aged 10+) is as follows (16):

ARITHMETIC—PAPER A

Tuesday, November 28th, 1882
6 p.m.-8 p.m.

1. Multiply £68 17 4½ by 114.
2. Divide £7851 0 9 by 114.
3. Add together: 48 lbs. 8 oz. 11 dwts. 13 grs; 116 lbs. 3 oz. 8 grs; 4 oz. 1 dwt. 2 grs; 166 lbs. 1 oz. 13 dwts. 10 grs; 68 lbs. 3 dwts. 3 grs; 17 lbs. 10 oz. 5 dwts.
4. Find the difference between 1000 mls. 3 fur. 17 pls. 0 yds. 2 ft. and 998 mls. 5 fur. 6 pls. 2 yd. 1 ft.
5. Multiply 55 Eng. Ells. 2 qrs. 1 nl. 1½ in. by 47.
6. Divide 2241 mls. 4 fur. 16 pls. 5 yd. 1 ft. by 118.
7. Find the value of 3033 articles @ £1 19 10½ each.
8. Add together $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$.
9. Reduce 7/10½ to the fraction of 8/4½.
10. Simplify $\dfrac{\frac{2}{3}+\frac{1}{2}\text{ of }\frac{2}{3}}{\frac{4}{5}-\frac{2}{3}\text{ of }\frac{3}{10}}$ of £1 13 4½
11. The house tax upon a house rated at £183 15 0 is £6 17 9¾, what will it be on one rated at £120?
12. Find the Simple Interest on £275 12 6 at 4½ per cent for 3 yrs. 6 months.

The teaching of the day could not have lacked thoroughness or sturdiness and it was consistent in its purposes. Current educational theory was based on the view that the mind consisted of separate faculties which could be developed and strengthened. Consequently the first objective in teaching arithmetic was the provision of intellectual exercise for the purpose of mental training and discipline. On this theory, difficulty and dullness in the work could be considered an advantage and the pupil's attitude safely ignored. If the subject inspired dislike, it would serve all the better as a means of mind training. Syllabus content could be regarded as a matter of secondary importance.

Doubtless some pupils could and would respond to these methods, especially at the hands of skilful devoted teachers. Such teachers, themselves part and product of the educational system, would be enthusiastic for the subject and confident of the soundness of their teaching theory and practice. Thus in 1837, William Whewell, a well-known Cambridge figure who later became Master of Trinity College, could vigorously defend an overemphasis of geometry at the expense of analytical mathematics at university on the grounds that whereas the latter employs mechanical methods and only makes mathematicians, the former trains the mind in the art of reasoning. "We do not wish our pupils to possess mathematics principally as information, nor even as an instrument . . . but as an intellectual discipline," he writes (17). Before the mind can usefully be employed in scientific research, "habits of thought must be formed in other subjects", and mathematics, correctly taught, is particularly useful in this respect. There were others, notably Augustus de Morgan, less satisfied, however, and presently, in 1871, the Mathematical Association was formed as the "Association for the Improvement of Geometrical Teaching" with an original membership of 61.

It is possible to exaggerate the pedantry of these times. Nevertheless, a system of education was in being in which the nature of the pupil's psychological make-up and his educational needs were being misunderstood. The overemphasis on computational skill in arithmetic defeated its own purpose and the average pupil acquired neither skill, knowledge nor understanding. The faulty attitudes towards mathematics which exist to-day must surely be viewed against this background to be fully understood.

The educational principles on which the teaching of arithmetic was based were similarly operative in other branches of mathematics, particularly in geometry, a synonymous term for which was Euclid. As the finished product of the Greek mind, Euclid's geometry was clearly the subject *par excellence* for the training of the young mind and it dominated the mathematical scene in our schools. Yet Euclid takes no account of the historical development of the subject and gives no indication of how proofs were originally arrived at. The biggest difficulties come at the beginning when the pupil is least able to cope with them. Each theorem employs its own methods and techniques and so makes fresh demands on the ingenuity of the learner. Solid geometry comes at the end of the course whereas it is desirable pedagogically that it should come at the beginning. The logical sequence of the propositions and the structure of geometry, wherein lies Euclid's chief beauty, cannot be appreciated by the beginner for the study needs to be completed first.

Although Euclid had been abandoned as a school text-book on the continent over a century earlier, we find as late as 1900 that the Board of Education recommended that the study of Euclid be commenced as soon as the pupil could read easily and grasp the meaning of the axioms and definitions (18). The wording of the text was to be adhered to and the enunciations and corollaries learnt by heart. Few riders, if any, would be attempted for Euclid contained none. There would be no drawing or measurement, and no protractors, Euclid being concerned only with the general angle. Methods involving the use of arithmetic or algebra were forbidden. Geometry so studied could have had little practical or educational value. Unlike arithmetic, the subject did not even afford the opportunity or satisfaction of getting sums right. The study of Euclid was later supplemented in some schools by practical drawing and mensuration courses in plane and solid geometry. Also, riders and exercises made their appearance in text-books: in L. J. V. Gerrard's *Geometry* (1874), for example, which contained a few, and in the familiar "Hall and Stevens" (1888).

Fundamental reconsideration of the teaching of geometry became possible in 1902 when the universities agreed to relax their entrance examination requirements. In 1905 the Mathematical Association published a report (19) in which it was stated that the first introduction to geometry should be experimental and not formal. It should make use of instruments and include numerical measurements and calculations. "The importance of this change can hardly be exaggerated", writes A. W. Siddons, "because the requirements of the University entrance examinations dominated the teaching of Geometry in the schools; until the Universities moved, the schools could do little. It was probably the greatest reform ever made in the teaching of any subject; it was the forerunner of many reforms in mathematics and in other subjects (20)." Plato assured for geometry a dominant place in educational thought and practice which it continued to hold until the present century and there is no doubt that the teaching of Euclid exercised a considerable influence on the teaching of arithmetic. Transformation in the one field was accompanied by corresponding changes in the other.

The teaching of arithmetic in the elementary schools fared no better than in the endowed schools. The Newcastle Report appeared in 1858 and, in consequence, the system of "payment by results" was set up in 1862. The arithmetic syllabus prescribed at this time was as follows (21):

Arithmetic Schedule (1862 Code)

Group 1 (3-7 years)
Form on blackboard or slate from dictation, figures up to 20; name at sight figures up to 20; add and subtract figures up to 10 orally from examples on the blackboard.

Group 2 (7-9 years)
A sum in any simple rule as far as short division of number.

Group 3 (9-11 years)
A sum in compound rules (money or common weights and measures).

Group 4 (11 years upwards)
A sum in practice or simple proportion.

Matthew Arnold commented on the working of the system in 1869, seven years after its inception: "The object being to ensure that on a given day a child shall be able to turn out, worked right, two out of three sums of a certain type, he is taught the mechanical rule by which sums of this sort are worked, and sedulously practised all the year round in working these; arithmetical principles he is not taught, or introduced into the science of arithmetic (22)". This criticism was reiterated by many writers but the parrot-learning continued in extreme form until towards the end of the century when changes of consequence began to take place.

The Balfour Education Act of 1902 allowed attention to be turned from external problems of administration to internal problems of teaching. Restrictions on syllabuses were removed and teachers were given freedom to experiment. The ending of payment by results had generally resulted in a marked improvement in the teaching of arithmetic. According to J. R. Blakiston, a Chief Inspector of Schools, common sense began to take the place of routine in number teaching and the children were being taught to think (23). The magnitude of the change in outlook then taking place can be judged by comparing the 1890 Arithmetic Schedule, the last to be issued under "payment by results", Scheme B (1894-1902), and an illustrative scheme prepared in 1912 by H. J. Spencer. The respective syllabuses for Standard 4 are given below. The 1890 Schedule differed from the 1862 Schedule quoted above in that it provided a separate syllabus for each of the seven standards of the all-age school which had then come into being. Girls were to be treated more leniently than boys and were not to be taught recurring decimals. Scheme B was intended as an alternative to the 1890 Schedule and gave some attention to underlying principles.

STANDARD 4 ARITHMETIC SYLLABUSES

1890 Schedule (24)

Compound Rules in money and reduction of common weights and measures

Scheme B (*1894-1902*)(25)

Compound rules applied to the following weights and measures (capacity, time, weight, length). In length: yards, feet, inches; in weight: tons, cwts., qrs., lbs., ozs.; in time: days, hours, minutes, seconds; in capacity: gallons, quarts, pints—are the only terms that will be required in this and in the fifth standard. Divisors and multipliers not to exceed 99.

Illustrative Scheme, 1912, by H. J. Spencer (26)

First Half-Year

Notation and numeration to tens of thousands.
Factors. The four rules to four figures, carrying to five.
Division by factors and easy long division.
Money.
Linear: yards, feet, inches, easy miles and yards. Distances from school to well-known buildings. Height of school and tall chimney.
Height, length and breadth of classroom, hall.
Weight: tons, cwts.; and lbs. ozs., ton of coal, 10 sacks, stone as 14 and 8 lbs.
Liquid: gallons, quarts, pints. 9 and 18 gallon casks.
Four rules and reduction with small numbers. Division by factors and easy long multiplication.
Method of unity by first finding for one. Easy direct and indirect proportion.
Use of tenths from rulers, squares, half-sovereigns and shillings.
Four rules orally.
Decimal expression. Four rules with easy integers and tenths.
Common fractions with denominators 2, 3, 4, 8, 10, 12.
Four rules. Multiplication and division, whole numbers only.
Practical Geometry—As in previous class, more advanced.
Fold Rhombus.
Bisect by folding sides of any triangle at right angles.
Bisect by folding angles of any triangle, and note the result.

Second Half-Year

Four rules and reduction. Money, Linear, Weight. Liquid as in previous class occasionally, as revision only. Add chains, yards. Time: months, weeks, days, and hours; minutes, seconds, years, weeks, calendar months.
Short methods of working multiplication of money.
Addition and subtraction of common fractions with easy and small denominators.
Multiplication and division by integers.
Use of tenths and hundredths. Decimal expression and four rules, working answer to two places.
Method of unity, direct and indirect, using very easy money and weights and measures.
Areas of squares and rectangles. Distances round rectangles.
Ideas of standard yard and lb.

Four rules with common and decimal fractions from divided square and rectangle and from rulers.
Diagrams to show that $\frac{1}{2}=\frac{2}{4}=\frac{4}{8}=\frac{8}{16}$ etc.
Use metre rulers. Centimetre.
1 metre $=39\frac{1}{3}$ inches nearly. 1 in. $=2\frac{1}{2}$ cm. nearly.
Estimate parts of $\frac{1}{10}$.
Use of graduated pint glass.
Gallon of water weighs 10 lb.
Use of callipers and wedge for internal and external diameters.
Practical Geometry—Superposition of triangles. Two sides included angle.
Three sides equal.
Use of compasses to carry distance, to make circles, and geometrical figures involving circles.
Folding circle to get 180°, 90°, 45°, $22\frac{1}{2}$°.
Parallels with set-squares and by eye. Non-parallels meeting.
Parallelograms.
Scale drawing, 1 inch to foot and 6 inches to inch from actual measurements of objects.

The new trends in the teaching as observed in London elementary schools were summarised in 1912 by Ballard (27), who noted that arithmetic was passing into mathematics and that the claims of geometry, mensuration and algebra were obtaining at least some recognition. Fixed conventional types of sums were being abandoned, examples were being brought into close relationship with the children's everyday life and an abundance of practical work was being introduced. Ballard also stated that at this time, out of seventy schools chosen as typical in the London area, sixty were still using syllabuses based on Scheme B.

Though few schools had given practical effect to the different viewpoint, a new era in the teaching of mathematics had undoubtedly arrived. Readjustment is far from complete even to-day, for schools are still in a state of uneasy transition and flux. Nevertheless, slow and gradual improvement has steadily taken place during the intervening years in spite of two world wars and unfavourable teaching conditions. The radically changed outlook is becoming more widely understood and appreciated and we are seeing the results, particularly at the level of the infant school, where excellent pioneer work has been undertaken in recent years.

The doctrine of transfer of training of the earlier century has undergone considerable modification and it is now considered necessary to "train for transfer" in order that arithmetical knowledge and skills may overflow into their relevant fields of application. Present-day learning theory stresses the need for correct attitudes to be formed. The pupil's interest and co-operation in the classroom must be sought and won. The teaching must relate arithmetic to the experience and everyday life of the pupil so that he may realise for himself that the study of the subject on which he is embarking is personally worth while. Teaching must await insight and the pupil must so understand the subject that he remains its master at each stage of its development. Knowledge must be built upon well-established number concepts born out of concrete experience and grounded in practical situations. Blind learning is to be avoided; instead the pupil must be taught the mathematical way of *thinking*. The teacher's task is not merely to teach arithmetic but to teach arithmetic *to children*; and supreme importance attaches to the choice of material and the method of its presentation. Thus, the pupil's attitude to the subject, his ability to apply his arithmetical knowledge in appropriate situations and his power of mathematical thinking are among the major concerns of the teacher.

The practical consequences of the change in attitude we have been considering are too well known and recent to warrant detailed description. We note the use of smaller numbers and the choice of more "realistic" examples. Work on fractions, for instance, tends to concentrate on those in common use with small denominators, for which L. C. M.'s can be obtained by inspection, and sums in reduction (28), long division in number, and long multiplication of money, assume more modest proportions. The introduction of estimations and approximations is specially noteworthy. As late as 1907, the length of the newly constructed Brooklands track was published as 2.171762547 miles. The only tables then in use were 7-figure tables (Chambers's Tables were first published in 1883 and a twelfth reprint appeared in 1903) and they were used to the limit, even to seconds of angles. 4-figure tables were despised by mathematicians as good only for rough approximations!

Other changes include the introduction of oral methods and there is an increased emphasis on practical work. The necessity of teaching underlying principles is now generally recognised. The rigid separation of the various branches of mathematics has been broken down and syllabuses have been considerably modified and reduced in content in order that the teacher may better help his pupils to understand the subject. Cube roots have gone altogether, as have recurring decimals, together with much financial arithmetic. It is illuminating to compare 11 + arithmetic examination papers of to-day with the corresponding papers of 10, 20 and 30 years ago. Some will consider, indeed, that the reaction against traditional methods has sometimes gone too far. For example, the increased emphasis on understanding may have tended to obscure the need for the child *to learn* his arithmetic. Perhaps this is in part responsible for the number of new text-books now appearing which deal exclusively with the number facts of "mechanical" arithmetic, a tendency which at first glance seems retrograde.

In spite of all attempts at improvement, failure in arithmetic persists and is widespread. There is no lack of evidence to this effect, as witness the result of the investigation into the arithmetical attainment of training-college entrants recently reported by W. O. Storer (29). Some four years ago, a similar investigation was carried out by a Local Authority in respect of the 10-year-old children in its schools. Some 1,112 children, consisting of the whole of the 10-11 years age group in thirteen junior schools selected as typical, were examined in the mechanical processes of subtraction, short multiplication and division (five simple sums per section). It would be tedious to give full details but the percentages of children who were below 70% accuracy in the respective processes were 18, 20 and 30. The corresponding figures for the combined B and C streams were 30, 32 and 45 and for the A stream, 2, 2 and 4. The zero difficulty was much in evidence. It seems reasonable to infer that a high rate of failure would attach to the weaker group in problem type sums which require the use of one or other of these processes.

These figures are of particular interest in view of the fact that the teachers in the area had been at some considerable pains to improve the quality of their teaching of arithmetic for some years previously. They had worked out and agreed to accept a modicum of standardisation of method. The 11+ examination papers were set and marked by the teachers themselves. The questions were of a type to encourage teachers to concentrate on fundamentals and the controlling influence of the examination was thus used beneficially in this respect. That improvement had taken place was shown by an earlier investigation. Even so, the failure rate with the weaker pupils was higher than one would wish to see and it prompts deeper inquiry into its causes.

It may be remarked that some degree of uniformity in arithmetic method seems desirable in schools which serve a given area if only for the sake of the secondary-school teachers. Although Mr Flavell in his article takes a contrary standpoint, he writes strongly in favour of a particular approach to the teaching of zero.

Presumably this method is used throughout his school. If this is advantageous in one school, why not in all schools in the area? From the point of view of the child, it does not seem to matter much which method of subtraction is chosen, for example, provided it is well taught and the child masters the method. The child worries, however, if he is asked to change the method later. One finds an astonishing variety of methods, some of them crude, used in elementary arithmetic by mathematics students at college who, nevertheless, like the subject well enough to want to teach it. The implication is not so clear, however, in the case of weaker pupils.

One can agree unreservedly with the contention of Mr. Flavell that a main reason for failure in arithmetic is that teachers are inclined to teach the subject as they themselves were taught as children, thus tending to perpetuate the use of unsound methods. The traditional outlook remains deeply entrenched in our schools and there still occurs teaching of a type which can only be justified in terms of outworn theories of mental training. Most, if not all, teachers were brought up and nurtured in the shadow of these theories. Each of us tends to base his teaching on them without realising it. We are, indeed, as much prisoners of the contemporary system of education as were our colleagues of the 1850s and the first step towards detachment and freedom of thought is to realise this. The headmaster who sent in a figure of 113.2476, when asked at short notice by his Director of Education to obtain the I.Q. of one of his pupils, was presumably an unwitting victim of traditional teaching. Students in training, when under stress on teaching practice, are prone to reproduce the methods used by their teachers at school; these may well conflict with the more up-to-date theories of teaching which the students have professed to understand and accept in their method classes.

The passing of the bulge from the junior school, the lengthening of the period of teacher training to three years and the improved climate of opinion towards mathematics combine to make the present time opportune for a fundamental review of aims and purposes in teaching elementary arithmetic. As a first step, we each need to look critically at the foundations of our individual classroom theory and practice.

NOTES AND REFERENCES

1. Readers are referred to the first chapter, "The History of Mathematics Teaching in England", of the Ministry of Education Pamphlet 36, *Teaching Mathematics in Secondary Schools*, which appeared while this article was in the press.

2. Ballard, P. B., *Teaching the Essentials of Arithmetic* (University of London, 1928), p. ix.

3. Flavell, J. S., "Some Reflections on the Teaching of Arithmetic", *Educ. Rev.*, x, 1 (1957).

4. In 1805, in the Leeds Grammar School case, it was ruled that no grammar school could use any part of its endowment income for the purpose of teaching French or German, or even Arithmetic and Writing. The situation was remedied by the Grammar Schools Act of 1840. See Archer, R. L., *Secondary Education in the 19th Century* (C.U.P., 1932), pp. 20, 83.

5. *Harrow Register.*

6. Lyte, Maxwell, *The History of Eton College* (Macmillan, London, 1875), p. 438.

7. The Taunton Commissioner for Yorkshire considered the classical learning given in the schools to be "a delusive and unfruitful thing". "It furnishes the pretext for the neglect of all other useful learning, and is the indirect means of keeping down the general level of education in almost every small town which is so unfortunate as to possess an endowment." *Report of the Schools Inquiry Commission* (1867), I, p. 133.

8. *The Report of the Schools Inquiry Commission* (1867) I, p. 29.

9. op. cit., IX, pp. 178-9.

10. op. cit., VII, p. 22.

11. The Commissioners distinguished in their Report between arithmetic and mathematics.

12. op. cit., I, pp. 30, 31.

13. Summarised extracts from reports on some Yorkshire schools from vol. XVIII of the Report are as follows:

Wakefield Free Grammar School (Classical; 80 boys)
All the boys take arithmetic and twenty-five mathematics, Euclid being taken in all five classes. There was an entire failure in mathematics throughout the school apart from three boys in Class 1, one of whom did thoroughly well and the other two creditably. In Class 2, none of the boys, in algebra, showed any power of working equations or managing symbols, and all made the most sad blunders for boys of fifteen. Arithmetic was generally well done.

Sedburgh (Classical; 13)
The Commissioner wrote, "I soon abandoned all attempt to examine with any detail."

Batley Free Grammar School (Semi-Classical; 53)
Eight boys were learning Euclid and algebra at an additional fee of 10/6 per quarter.

Burnsall Grammar School (Non-Classical; 43)
No boys took mathematics and twenty only took arithmetic. Of these "three could work Reduction and one was able to do a sum in Practice".

Leeds Grammar School (Classical and Semi-Classical; 200)
Seventy-seven boys were reading mathematics. Sound and efficient

instruction was being given in the three highest forms in Euclid, algebra, trigonometry and conics (geometrical and analytical).

Doncaster Grammar School and St. Peter's York, were described with Leeds as being "conspicuously above the rest".

14. Trotter, James, *A Complete System of Arithmetic, Theoretical and Practical* (Oliver and Boyd, Edinburgh, 1853), p. 43.
15. Colenso, J. W., *Arithmetic* (Longman, Green, Longman and Roberts, 1862 edn.).
16. Reproduced by kind permission of the Headmaster.
17. Whewell, W., *On the Principles of English University Education* (Parker, 1837), p. 43.
18. Allum, C. G., "The Teaching of Mathematics in Preparatory Schools", *Special Reports on Educational Subjects*, vol. VI (Board of Education, 1900).
19. *The Teaching of Elementary Mathematics* (Mathematical Association, 1905).
20. Siddons, A. W., "Fifty years of Change", *Mathematical Gazette*, XL, No. 333, October 1956, p. 163.
21. Revised Code of Minutes and Regulations of the Committee of the Privy Council on Education, 1862 (Art. 48).
22. Arnold, Matthew, *Reports on Elementary Schools* (1852-82) 1910, p. 128.
23. Blakiston, J. R., Report of the Committee of Council on Education, 1892-93, p. 13.
24. op. cit., 1890 Code (Art. 101).
25. Requoted from *Special Reports on Educational Subjects*, XXVI (H.M.S.O.), p. 26.
26. Spencer, H. J., "The Teaching of Elementary Mathematics in English Public Elementary Schools", *Special Reports on Educational Subjects*, XXVI (H.M.S.O., 1912), pp. 40-41. The suggested scheme of work for infants, which may be of interest to readers, is as follows:

Infant Department. 30 minutes per day, 5 days per week.

Grade 1 (3-4½ years). No number teaching except incidentally in connection with games, toys, etc.

Grade 2 (4½-5½ years). Elementary idea of number up to 6. Taught by games, concretes, drawing, etc. Number pictures to 6 arranged in bricks, cubes, counters, shells, beans, beads, etc. Number pictures drawn in dominoes, squares, circles.

Grade 3 (5½-6½ years). Comparison of lines, surfaces, solid.

Drawing of lines equal to, longer than or shorter than line drawn by the teacher.

Measurement using inch and foot.

Exercises to teach inch and half-inch marks on ruler.

To estimate these lengths. 6 in. rulers marked by children (paper) (1 in. square tablets used). Draw, mark and cut from 1 in. squared paper, squares and oblongs of 1, 2, 3, 4, 5, 6 in. side.

Foot, half foot—Exercises to teach 1 foot = 12 inches: half foot = 6 inches; pound and half pound; sticks of 1, 2, 3, 4 and 6 inches used to construct foot lengths. Tested by 12 in. ruler.

Pint and half pint—Exercises with actual measures and water.

Half and quarter. Taught by paper folding and cutting.
Half-Square folded into oblongs and also into triangles.
Quarter-Square folded into squares and also into triangles; paper pies, apples, etc., cut into halves and quarters.
Number—To count to and from 10 by ones, twos, etc. Analysis of numbers 1 to 10 into parts and factors. Keeping shop. No formal addition and subtraction. Very simple exercises. Concrete examples only. To make number dominoes and pictures. Apparatus—Strips of cardboard cut into lengths of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 inches, one set to be kept by each child. Bone counters, square tablets, beads, sticks, Gift 3. Gift 4, beans, shells, cardboard coins, measures squared paper (1 in, squares). Four inch paper squares.

27. Ballard, P. B., "The Teaching of Mathematics in London Public Elementary Schools", *Special Reports in Educational Subjects*, XXVI (1912), pp. 3-30.

28. As part of an attempt to discover how much use is made of mathematics in everyday life, the writer some years ago scrutinised four newspapers, the *Daily Telegraph*, *Daily Mail*, *Daily Herald* and *News Chronicle*, over a period of a fortnight 14th-19th, 21st-26th October 1951 to ascertain their mathematical content. Each newspaper followed a similar pattern and findings were averaged. The number of occurrences, over the fortnight, of compound quantities of two, three and four denominations was as follows:

Denomination	*Money*	*Length*	*Weight*	*Time*	*Capacity*
2	247	30	17	23	1
3	32	3	0	7	0
4	0	0	0	0	0

Decimals to 1, 2 and 3 places occurred 18, 8 and 2 times respectively. The quart unit could be found once only per newspaper over the fortnight.

29. Storer, W. O., "The Arithmetical Attainment of Entrants to Training Colleges", *Educ. Rev.*, IX (1957), pp. 113-116.

SEX DIFFERENCES IN THE VOCABULARY OF YOUNG CHILDREN

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1. The Sample

IN an earlier monograph (1) we reported the results of a survey of the spoken vocabulary of young children between 5 and 6½ years of age. The method of collecting the material and the results obtained are fully given in that report; for the benefit of those who have not read it we repeat the essential procedure here. We then go on to discuss a matter which did not appear originally, namely the differences in the vocabularies of the boys and girls observed.

A sample of 330 children was obtained, 165 boys and 165 girls equally distributed between the three age ranges 5-5½, 5½-6 and 6-6½ years, with 55 of each sex in each group. The children were drawn from infant schools, both urban and rural, over a wide area of the Midlands, and no more than four children were selected from any one school. Students from training colleges in the area co-operated in collecting the data; each student selected at random one boy and one girl from within her given age range (5-5½, 5½-6 or 6-6½), and spent 10 ten-minute periods with each of them, noting each different word the child used. Once it had been recorded it was subsequently ignored. Everything was done to encourage the child to talk freely about as many different things as possible; when conversation flagged, pictures, books and scrapbooks were used as stimuli and as something to talk around.

After sampling, an alphabetical list was prepared by each student for each child. These were consolidated, and separate lists were produced for each sex and each age range within each sex. From these lists two further lists were prepared; List I (the "Birmingham word list") in the appendix of the monograph showed the first 1,909 words, which were used by 5 or more of the 330 children; and List II in the monograph showed the remaining 1,595 words, used by 4 or fewer children. This report is based on List I; in other words, it is concerned with approximately 2,000 words, which were the words most frequently used by the children during the interviews.

The data obtained from this method of collecting do not show the frequency with which an individual word is used by the children being tested, but rather the number of children who used each individual word. To discover whether certain words were used by children of one sex more frequently than by children of the other, the data from which List I had been compiled were further analysed separately for boys and girls. The number of usages by boys and girls was separately counted for each word, and from these two numbers the significance of the differences in usages was tested. Two levels of significance were adopted, the 5% level and the 10% level. Those words showing a significant level of difference were listed according to the sex more frequently using them, and then subdivided into sections, under various headings, as, for instance, *Activities and Interests*, *Home* and *School*. For example:

Food

Girls:
- blancmange
- bread
- cherry
- coconut
- coffee
- crisps
- jelly
- rhubarb
- rice
- tea
- vegetable

Boys:
- honey
- loaf
- sausage
- wheat

The complete list giving the total number of words which showed a significant difference at the 10% level or better comprised 366 entries; 223 of these were used by boys and 143 were used by girls. The total number of these which showed a significant difference at the 5% level or better was 232; 148 of these were used by boys and 84 by girls. This list will subsequently be referred to as List III and it appears in full in the appendix. The separate columns headed "Girls" and "Boys" will be referred to as "girls' list" and "boys' list" respectively.

It has frequently been suggested that girls are more precocious in their language development than boys; from this it would be reasonable to expect that girls would show a wider range of vocabulary than boys, and that more words would appear in the girls' word count.

According to the figures obtained from this list, this does not appear to be the case. It must be borne in mind that these figures refer to the number of children using the word in question, not to the number of words used by each child. A check made from all the words listed in the original study showed that the average number of words used by boys and girls was, to the nearest whole number, 248 and 238 respectively. This difference is relatively small, especially when compared with the differences quoted in the previous paragraph. In a statistical survey of four separate fields of language skills in children (articulation of speech sounds, sound discrimination, sentence structure and vocabulary), Templin (2) finds that "the estimated vocabulary of boys . . . is consistently higher than that of girls at the same ages. However . . . differences between the estimated vocabularies of boys and girls are small and not statistically significant at any age level." The only occurrence of a sex difference which she found was in ability in the articulation of sounds: "The general articulation score increases with age until essential maturity in articulation is reached by 8 years. Boys take about one year longer than girls . . . to attain essentially adult articulation."

Our own findings agree with those of Templin in that there is no significant difference in size between the lists of words used by boys and girls respectively. There remains within these lists, however, a high proportion of words used significantly more often by one sex than the other, and such differences may probably indicate the factors which influence the vocabulary development of the two sexes. Drever (3) suggested that the three factors influencing vocabulary development are (i) environment (ii) mental growth, and (iii) direction of interest, and our material will be discussed under these three headings.

2. INTEREST

Interest is likely to produce a very marked effect on vocabulary, providing in itself a stimulus towards self-expression; since even at 5 or 6 years of age, boys and girls are already developing different fields of interest and activity, we should expect to find differences in vocabulary. In the section *Activities and Interests* in List III, there are 10 words for girls and 60 for boys. The numerical difference is not important since many feminine interests are listed under different heads. But inspection of the first six words, in alphabetical order, from boys' list and girls' list, will show the differences in the types of words used:

Activities and Interests

Girls:	Boys:
ballet	aeroplane
bead	arrow
cracker	badge
crayon	bandit
doll	bomb
knit	brake

On the other hand, in the *Clothes* section, girls have 14 entries as against 6 for the boys; and while the boys' interest in clothes is strictly practical and utilitarian (they talk about *jacket*, *jersey*, *pullover* and *trousers*), the girls show a much more "sophisticated" interest in clothes from their adornment point of view, and talk about *nylons*, *necklace* and *handbag*, as well as other items of dress. The greater interest of girls in home matters even at an early age is described by Gesell and Ilg (4) in their book *The Child from 5 to 10*: "Girls build houses for their dolls and project personal situations, whereas boys build roads, tracks, bridges, tunnels, and use their houses for tanks, airplanes, army trucks and fire-engines. . . . Girls are more likely to play school, house and library, but certain boys are often ready to join them. Girls also like to dress up in costumes, including hats, slippers, lipstick and housecoats and may at times turn their play into a dramatic performance."

The three sections *Colours*, *Flowers* and *Animals* also show some differences. Colour-words, if rather limited in range, appear to be more often used by girls: they have three entries, all of which are significant at the 5% level or better, while the boys have only one entry, significant at the 10% level or better. It is interesting to note that the boys' one colour entry is the word *white*, while the word *black* appears as a colour-word entry for the girls. Girls seem to know the names of more flowers than do boys, though it is strange that the one flower name that appears in the boys' list should be the word *violet*—it would be easier to imagine boys talking about daisy or dandelion. Boys also use the word *weed* whereas the girls have the rather poetic word *blossom*. In the section on *Animals*, however, there are 15 entries on the boys' list for names of animals, as against 6 on the girls'; only one nursery word (*nanny-goat*) appears among the boys' words, whereas the girls have *bunny* and *quack*. While the girls have the general and indefinite word *bird*, the boys use the proper names for *sparrow*, *robin* and *duck*, and use the general class-names *fowl* and *cattle*. With the exception of the word *snake* the girls' words are all for animals or insects which are common and fairly often seen, but the boys know the names for *camel*, *lion*, *reindeer*, and more common but not frequently seen animals such as *mole* and *newt*. Boys know three different words for places where animals live, i.e. *sty*, *hatch* and *hive*, but girls only have the word *zoo* on their list.

3. ENVIRONMENT

Under the heading of environment, the first aspect to consider is obviously the home. Although at 5 and 6 years of age, the child has entered upon the new and strange sphere of school, he is still very closely attached to his home. Because of this, and because both girls and boys presumably have a very similar environment of home, school and town or village it would be easy to expect that there would be no sex differences here. In fact it is interesting to notice that while the boys have the word *home* itself on their list, the girls have a longer list of significant words than the boys. In general, the words in the boys' list are practical, concrete words, to do with the fabric of the house, whereas the girls' words are more to do with the furnishings and the running of the home. Similarly the larger number of words in the girls' list in the section headed *Food* probably reflects this home interest—Gesell (4) often points out that girls at these ages commonly like to play at house. Again the section headed *Family and People* reflects this greater domestic interest of girls: the boys' interest is in such close relatives as *daddy*, *father* (boys and girls have the word *mother* almost an equal number of times, though the diminutive *mam*, *mamma*, or *mammy* appears in the girls' list) and *grandmother*, and in relatively few people outside the family circle, the only other words which appear on this list being *kid* and *Miss*, which perhaps refer to his friends and the teacher. The girls' interest in people extends beyond relatives (*aunt*, *brother*, *grandma*, *ma*, *sister*, *twin*) to include *lady* and *visitor*, and seems to reflect also the idea of marriage (*marry*, *Mrs*, *wife*, *baby*, *bridesmaid*, *child*). It may be that a greater interest in people is part of the mental make-up of girls; Gesell (4) suggests this when, in a discussion of the subject-matter children choose for their drawings, he remarks that whilst boys draw people almost incidentally to other objects, girls appear to prefer to draw people. He also suggests that when boys play with dolls as they sometimes do, it is rather to re-live the experience of their own babyhood than to treat the dolls as imaginary children, as girls tend to do.

The other important aspect of the child's environment is his school life, and in the section headed *School and Learning* 5 words appear for the girls and only one for the boys. This word (*poem*) is not specifically a "school" word but it was thought most likely that the boys would come across poetry first in school. In view of the predominantly practical interests of boys the appearance of this word in their list is unexpected. Girls have the word *rhyme*. The greater number of words in the girls' list in connexion with school activities may suggest that girls are more interested in school than are boys; perhaps this is stretching a point, but in fact Gesell asserts that it is the case. It may be that our junior-school activities are differently organised from the American "first grades", but these words in the girls' list do refer to the mechanics or tools of learning (*board*, *book*, *desk*, *question*) rather than to the play activities mentioned by Gesell.

To deal with the third aspect of environment, geographical environment, the two sections headed *Landscape* and *Weather* may be considered together. In the section headed *Landscape* there are 11 words in the boys' list, and only one (*moor*) in the girls' list. The boys' list reveals a quite wide knowledge of different types of natural scenery (*island*, *lake*, *mountain*) and of objects of interest (*farm*, *fountain*, *windmill*). Words such as *land*, *place*, *world*, contain in them a larger concept than the purely visible (or visual) concreteness of, for instance, *mountain*.

In the section headed *Weather* there are no entries for girls, and the boys' entries all suggest physical discomfort, mainly cold. This may be compared briefly with the section headed *Abstract words—Adjectives*, where the boys' list consists of words which all, with the exception of *deep*, describe a physical state, especially *cold* and *warm*, whereas not one of the words in the girls' list has any such connotations. It is possible that these words point to an interest in natural phenomena, just as the possibility of interest in natural scenery and surroundings was suggested by the contents of the boys' list in the section headed *Landscape*. Gesell (4) found that at six years the child ". . . acquires elementary notions of natural science—growth, nutrition, cleanliness, weather, seasons, etc."

In the field of environment, then, it would seem that since many more girls use words connected with home, school, family and people, and more boys use words connected with natural or geographical surroundings and weather, girls are rooted in the more domestic sphere, while boys are looking outside for wider scope. Again to quote Gesell: "Girls as a rule, with a greater fluidity of mental structure and with a more flexible but continuing contact with their environment, do not experience the more extreme patterns of disorganisation that boys exhibit. Girls are better at conforming."

4. MENTAL DEVELOPMENT

So far, the two types of influence on verbal expression which have been discussed, interest and environment, have been closely interdependent; interest has influenced the words which refer to the environment, and the environment has helped to form the child's interests. The third type of influence on verbal expression is mental development, and this is also closely related to the other two.

The sections in List III which appear to be connected with mental development are those sections containing numbers and the so-called "abstract" words.

The section dealing with numbers shows a higher frequency in the girls' list of the numerals *six* and *three*, and in the boys' list of the numerals *fifteen* and *four*, which would appear to suggest that both girls and boys have at least some grasp of numbers and can use them. The appearance in the boys' list of *group*, *pound*, *much*, *little* and *some* is interesting, since Gesell places the ability to make simple measurements and label quantities and series at 6 years of age for both sexes. Possibly the girls, who seem to be less practically-minded, do not feel any need to discriminate between measurements; they use the word *all* with greater frequency than do the boys.

Those sections headed *Abstract words* are a loosely-knit collection of non-visual or non-concrete words, many of which could well have been placed in some other section. It is unwise to classify children's words too rigidly as "abstract" or "concrete", as they tend to be influenced by the situation and to be coloured by special emotional overtones which the word may have gathered for the child. Much may depend on the usage of a word at the moment when it was learned; for instance, a child may use the formula "Mother gave me permission", but may be unable to use the word "permission" in any other context. But from the point of view of the influence of mental development on verbal expression it is interesting to have them grouped together, particularly as Watts (5) suggests that language may be arranged in levels of increasing generality, from "labels" for concrete and particular objects to universal and abstract concepts. Intellectual growth in young children is indicated by "increasing mastery of the general statement", and somewhere along the road from the particular object to the universal concept the abstract noun makes its appearance. It is interesting to note that *beauty* and *love* appear in the girls' list, whereas the boys' list consists of such words as *sight* and *speed*; this reflects the suggestion made earlier that while boys are interested in more practical and outward things, girls are less active and perhaps not only more in contact with their domestic environment, but more inclined to retire into it. The two words *blame* and *trouble* appearing in the girls' list suggest that the idea of wrong-doing is more present to them than to the boys. *Magic* and *secret* in the boys' list suggests that it is the boys who are "susceptible to semi-abstract symbols, charms and spells" as Gesell finds all children tend to be at age 6.

A similar distinction exists betwen the "abstract" verbs used by girls and boys as was found with the nouns discussed in the last paragraph; although the verbs are non-visual, they are nevertheless active, "doing" words in the boys' list (with the possible exception of *forget* and *matter*), while the girls' words do not express much activity. The boys' words are positive words (*am*, *can*, *do*), while the girls' words are less positive, almost passive words (*may*, *wish*, *be*).

As was suggested earlier, the boys' adjectives, with the exception of *deep*, all suggest the idea of a physical state: *cold*, *free*, *warm*. The girls' list contains words which are not so much personal as objective in that they are the result of observation: *ordinary*, *pretty*, *neat*. *True*, like *beauty* in the previous section, looks like an approach to a genuine abstraction, but as was pointed out above, it is dangerous to categorise children's words according to adult grammatical classifications.

The sex difference in the use of adverbs, prepositions etc., seems a little haphazard at first sight. Three prepositions of place (*against*, *at* and *under*) occur in the girls' list, and five in the boys' list (*along*, *in*, *inside*, *over* and *where*). There is no apparent reason to distinguish between these words, as they are all reasonably simple space-relation words, and all well within the grasp of average children of this age.

One preposition of time occurs in each list: the girls have *since* and the boys have *ago*. Both these words express past time, but both past and future as well as present time is usually understood well before five years, and there is no reason to suspect any particular sex difference in the age group studied here.

Just and *rather* are adverbs of degree, and appear in the boys' list; no comparable word expressing degree of quality appears in the girls' list. Perhaps this difference is similar to the one found in the section on *Numbers*, where boys distinguished between measures and quantities, whereas only the work *all* appeared in the girls' list.

The words *else* and *perhaps* appear on the boys' list, and the word *because* appears on the girls' list. Words such as these imply causal relationships, or exceptions to such relationships, and Watts has maintained that children under the age of 7 years are unable to use them correctly. He suggests that it is not until they have reached this age that children learn there are general rules of behaviour for things and persons and become able to grasp a relationship of event and consequence, and the idea of exceptions to such a relationship. It is therefore possible that although the children in our sample used such words with significant frequency, they did not attach to them their ordinary meaning. The word *because*, used more frequently by the girls, implies a causal relationship; the words *else* and *perhaps*, used more frequently by boys, imply exceptions to such relations. There is no evidence to account for this sex difference.

One last note: *I* appears on the boys' list, though no other pronoun is entered in either list, and no pronoun at all appears in the girls' list. It will be recalled that in the section *Abstract words—Adjectives*, a consideration of words related to a physical state of being led to the tentative suggestion that perhaps boys used more personal, subjective words while the girls' list showed more objective, observation words. This sex difference in the use of pronouns appear to be comparable. A further comparison with the section *Abstract words—Verbs* will show that *am* also appeared here on the boys' list and presumably 'I am' appeared together as a unit.

5. CONCLUSION

In summary, three points may be made:

(i) The over-all sex differences with regard to extent and range of vocabulary are small and unlikely to be significant. There is certainly no evidence that girls show a more precocious language development than boys.

(ii) Those words which are used by significantly more girls than boys are words relating to home-school-people, which seems to be the field where girls' main interest lies, whereas the boys' list contains words expressing energetic outgoing activities and practical interests.

(iii) Apart from words in the home-school-people and closely connected sections, such as clothes, where the girls use many words and know the names of many objects, they tend to be vague and inexact in their "labelling" of creatures and things. The girls, for example, have *bird*, where the boys have *robin*, *sparrow*, *duck*; and they have a sole group-word *all*, where the boys have *group*, *pound*, *much*, *little* and *some*. On the other hand, this tendency toward vagueness appears to give them a greater degree of "abstraction" in their "abstract" terms. The girls have, for example, *beauty* and *love*, compared with the boys' *sight* and *speed*; and they have *true* and *best* compared with the boys' *cold* and *warm*.

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APPENDIX

List III

* Those words in which the difference is significant at the 5% level or better are marked with an asterisk.

Colours

Girls:	Boys:
black*	white
blue*	
pink*	

Flowers

Girls:	Boys:
daffodil*	violet*
lilac*	
lily*	weed*
tulip*	
blossom*	
garden*	

Animals

Girls:	Boys:
bird	bee*
bunny*	bulldog*

Animals (cont.)

Girls:	Boys:
butterfly	camel*
fly*	cattle*
quack*	duck*
snake	fowl*
	frog*
paws*	lion*
	mole
zoo*	nanny-goat*
	newt
	rat
	reindeer*
	robin*
	sparrow*
	beak
	hatch
	hive
	sty

Food

Girls:
- blancmange
- bread*
- cherry*
- coconut
- coffee*
- crisps*
- jelly
- rhubarb
- rice
- tea*
- vegetable*

Boys:
- honey*
- loaf*
- sausage
- wheat
- bite*

Clothes

Girls:
- beret
- button
- cape
- dress*
- frock*
- handbag
- jumper*
- knickers*
- necklace
- nylons
- petticoat
- pinafore*
- shoe*
- skirt*

Boys:
- headdress*
- jacket*
- jersey*
- pullover*
- trousers*
- wrist-watch*

Parts of body

Girls:
- ankle
- arm
- feet
- nose
- stomach*

Boys:
- beard*
- hair*
- leg*
- moustache*

Home

Girls:
- basin
- basket*
- bag
- baker*
- beaker

Boys:
- barber*
- box*
- break
- building*
- coal

Home (cont.)

Girls:
- bed*
- bought*
- broke*
- brush*
- buy*
- carry
- coke*
- cot*
- drawer*
- mirror*
- oven*
- packet
- pram
- sack
- serve
- shine*
- tile
- tobacco
- window*

Boys:
- concrete
- drain
- fence
- fire*
- home*
- key*
- knob*
- lock
- pet
- tin
- yard

School and Learning

Girls:
- board
- book*
- desk
- question*
- rhyme*

Boys:
- poem

Family and People

Girls:
- aunt*
- baby
- boy
- bridesmaid*
- brother*
- child
- grandma
- lady
- mam*
- marry*
- Mrs*
- sister
- twin*
- visitor*
- wife

Boys:
- daddy*
- father*
- grandmother*
- kid
- Miss*

Activities and Interests

Girls:
- ballet*
- bead
- cracker*
- crayon*
- doll*
- knit*
- material
- plait*
- thread
- walkie-talkie*

Boys:
- aeroplane
- arrow*
- badge*
- bandit*
- bomb*
- brake*
- buffers*
- bullet*
- cannon*
- carriage*
- climb*
- coach*
- conductor
- cowboy*
- crane*
- crook
- deck
- dive
- electric*
- engine*
- express*
- fight
- film*
- firework*
- football*
- Forces*
- fort*
- funnel*
- gather*
- ghost
- gun*
- hide
- hoop
- horn*
- Indian*
- jump
- lorry*
- map
- match*
- meccano*
- model*
- murder*
- paint*
- pedal*
- pirate*
- saddle*
- scout*

Activities and Interests (cont.)

Girls:

Boys:
- signal*
- spear*
- station*
- sword*
- tank
- tender*
- tommy-gun*
- trailer*
- trap
- trowel
- tunnel
- war*
- yacht*

Numbers

Girls:
- six*
- twice*
- three
- all*

Boys:
- fifteen
- four*
- group*
- little*
- much*
- pound
- some

Weather

Girls:

Boys:
- fog*
- frost*
- ice*
- snow*
- wind*

Landscape

Girls:
- moor

Boys:
- farm*
- fountain*
- ground*
- island*
- lake*
- land*
- lane*
- mountain*
- place
- windmill*
- world*

Abstract words—Nouns

Girls:
- beauty*
- blame
- love
- trouble*

Boys:
- air*
- fun*
- magic*
- minute
- secret
- sight
- speed
- way

Abstract words—Verbs

Girls:
- ache
- be
- die
- has
- may*
- see*
- wish

Boys:
- am*
- can
- do*
- forget*
- knew*
- matter*
- said*
- use*
- were*
- won't

Abstract words—Adjectives

Girls:
- best
- neat
- ordinary*
- own
- pretty*
- such*
- true*

Boys:
- cold*
- deep*
- free
- warm*

Adverbs, Prepositions etc.

Girls:
- against*
- also*
- at*
- because*
- since
- those*
- too
- under

Boys:
- ago
- along*
- else
- for*
- I*
- in*
- inside
- just*
- over*
- perhaps
- what*
- where*
- whose*
- yes*

Other words—Nouns

Girls:
- dump
- fluff
- spot*
- pad*

Boys:
- accident
- bank*
- dwarf
- flash*
- gum
- hotel
- side
- stone*
- witch
- pile
- police
- post

Other words—Verbs

Girls:
- cough*
- dug
- leave*
- stamp*
- turn*

Boys:
- bump
- burst
- bust*
- chop*
- crash*
- drag*
- drown*
- fasten
- jingle
- kick
- kill*
- lay*
- line*
- lit*
- pull
- reckon
- scream
- spoil*
- squirt
- stride*
- stuck*
- torn
- tug*
- wag*
- whip
- wink
- won*

Other words—Adjectives

Girls:
- short*
- upside-down*

Boys:
- fast*
- heavy*
- wild*

INTELLECTUAL DEVELOPMENT IN THE PLAY OF YOUNG CHILDREN

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1. INTRODUCTION

THE importance of play both in the natural development of children and as a motivating force in their education is to-day widely recognised. It is therefore somewhat surprising that comparatively few studies have been made of development in play behaviour, especially in the early years from 2 to 5, when play is almost the sole vehicle of intellectual growth. This article provides an account of the results and impressions gained in the course of detailed and careful observations of young children playing naturally, either in nursery schools or in an experimental situation which closely resembled their familiar environment. The emphasis throughout the study was on the intellectual development revealed in play and on the significance of play for the intellectual growth of young children. To this extent, the work here presented differs markedly from the great bulk of studies in the field of play, as most of these have been concerned more with the emotional significance of play in fostering mental health.

2. HISTORICAL SUMMARY

For a fuller account of the literature relating to the role and significance of play in development, the reader is referred to the unpublished work on which this article is based and the references given there (1). Most of the systematic observational and experimental work in the field was carried out in the late twenties and early thirties of the present century. Especially important is the work of Van Alstyne (2), in which the main emphasis was on changes in the duration of play sequences with increasing age (3), but which devotes some consideration to development in the use of play materials. Mention should be made also of the work of Charlotte Bühler and her colleagues, in particular her description of sequences in the predominance of different types of play (4), development in the handling of materials (5), and stages in the naming of children's constructions (6). Typical developmental stages in the handling of selected apparatus have been investigated by Gesell (7). However, only in the work of Barker, Dembo and Lewin (8) do we find an attempt to formulate a general scale of play development, applicable to a variety of materials, and stressing the organisational aspect of behaviour rather than its sheer duration. The present work owes much to the inspiration of their outstanding investigation. The well-known and important work of Susan Isaacs (9) provides an illuminating treatment of intellectual insight shown by a group of gifted children in a stimulating environment. Of more immediate relevance to the subject of the present study is the work of Margaret Lowenfeld (10), who analyses the functions of play and finds that these tend to manifest themselves in a definite sequence, albeit with considerable overlap: "Play as bodily activity is the earliest form of children's play. During the period that speech is being acquired, play as the repetition of experience gained in previous years is the next necessity of childhood. Play as the demonstration of phantasy follows hard . . . experience feeds phantasy and phantasy feeds experience." In later years, we are told, preparation for life, and for group games, assume a greater importance. A similar theme has been developed by Piaget (11) who admits of only three broad classifications of play: practice games, symbolic games, and games with rules. Practice games are "exercises" in which various groups of behaviour are practised for no other purpose than the mere pleasure of functioning (this is the "function play" of Ch. Bühler). Games become symbolic when they imply symbolic representation of an absent object, because here a distinction may be made between "signifier" and "signified". This category includes Lowenfeld's second and third group, repetition of experience and demonstration of phantasy, and to some extent her fourth, preparation for life. The last category, and also the final one to emerge, is that of games with rules, implying necessary social relationships. Piaget is at some pains to demonstrate why symbolic games assume particular importance during a certain period of life, i.e. from the second year of life to the age of about 4, and are less important later. He gives three reasons: first, the decline in the need for phantasy to compensate experience which is expanding; second, the increasing socialisation of play; and finally, the fact that as behaviour becomes more adaptive so children tend to be increasingly dissatisfied with the distorting element in imaginative play.

There is general agreement on the importance of symbolic play at a specific period. The most significant pointer to the rise and decline of this type of play is that it coincides with the period of speech development, as emphasised by Lowenfeld. Piaget (11) and Wallon (12) have stressed that language itself is but one (although the most important) vehicle of the key faculty which distinguishes human beings from all other animals: the power to represent objects and situations in their absence. While the symbols used in language and the actions and toys used in play both share the property of acting as "signifiers" to an absent content, the latter are easier of acquisition because they resemble that content, while the meaning of words, although governed by the laws of linguistic development, is psychologically conventional or arbitrary (13). Hence it would seem wholly natural that when children begin to acquire the power of representing objects and events in their absence, their linguistic equipment is as yet inadequate to enable the representative powers to function unaided. Symbolic play is therefore the natural mode of behaviour of young children, for this activity provides the closest link between action and representation. However, the ability to duplicate the data given in experience by means of a representational power, or, in Pavlovian terms, of a "sense signalling system" (14) would not by itself greatly add to the range of man's control over his environment, were it not that by means of language he is able to carry out complex and extended experiments in thought. Therefore the progressive complexity in their symbolic play is itself the ground on which children build the ability to use language as a substitute for action or as its preliminary, and no longer as a mere accompaniment. It is this growth in the complexity of children's play during the formative years of linguistic development which forms the main object of the present study.

It may be added that, from our present point of view, the logical development of symbolic play is not games with rules but, rather, the unaided functioning of language in conversation or in day-dreaming or in thinking. Games with rules, by their social character of "severance from life's purpose" (15), and by their motivational roots, whether in providing relaxation or in creating substitute sources of satisfaction for the ego, are related to the functional and especially the symbolic play of young children. But from the intellectual point of view, they have little in common, since the adaptations and command of social and objective reality necessitated by such games are in no way different in kind from those which enter into other forms of activity, e.g. routines and work.

3. Conditions and Methods of Observations

The observations to be reported covered a total of 63 children of whom the youngest was 2 years 2 months and the eldest 6 years 1 month. Of these, 41 were observed individually for four half-hour periods in their own nursery schools by their own teachers, who compiled a running record of their behaviour throughout. The remaining 22 were observed in more detail in groups of 3 or 4, these observations being carried out at Selly Wick House, under the auspices of the Research Department of the Institute of Education, Birmingham University. Their play behaviour was recorded by a total of six observers of whom two were in the play-room itself, recording the interaction of the group as a whole and as much as possible of their conversation, while the others watched the play from behind a one-way vision screen, each observer concentrating on one child. The play-room was laid out so as to reproduce as nearly as possible the conditions obtaining in a nursery schoolroom, while admitting of optimal conditions of observation. It was found in practice that with four children in a group, all known to each other, the presence of two adults, one being their own teacher, apparently absorbed in their own work, did not greatly disturb the course of their play.

While the observations in the nursery schools were made in the course of the ordinary activity of these schools, the conditions at Selly Wick House were deliberately varied on two occasions. To determine the effects of fatigue on play behaviour, one session was prolonged from 40 minutes to 100 minutes, the last 40 minutes of behaviour constituting the experimental situation. On another day, a large portion of the play materials was removed from the playroom, care being taken to remove those items which had proved most popular with the group concerned. The aim was to investigate the effects of restricted equipment in a less frustrating situation than that created by Barker, Dembo and Lewin, where the coveted toys remained in full view of the child, but separated from him by a wire grille. While the 22 children who came to Selly Wick House were seen at least six times, records of behaviour were analysed for only four sessions, two experimental and two control, the initial sessions being discarded as many of the smaller children did not settle down until they had spent two or three periods in the new environment.

The children in both groups were selected with a view to obtaining age-differences as clear-cut as possible. Those observed at Selly Wick House fell into one of four age-groups with ages centering at

$2\frac{1}{2}$, $3\frac{1}{2}$, $4\frac{1}{2}$ and 6 years. The nursery schools group had a narrower age-range, children being selected in three sub-groups with mean ages at 3 yrs. 1 mth., 3 yrs. 9 mths., and 4 yrs. 8 mths., the range within each sub-group varying from 4 to 5 months. The main criterion of selection for both groups was chronological age. All these children were normal children, although they varied considerably in their emotional adjustment. The Selly Wick group was selected from children who might be expected to make a good adjustment to a strange situation. Nevertheless, some of these children, and in particular the youngest children, drawn of necessity from a nearby day nursery, presented somewhat atypical home backgrounds. Every child in the two samples was given an individual intelligence test, either with the Terman-Merrill or the Merrill-Palmer test, in a few cases with both. In addition, in the nursery schools group each subject was given a rating of emotional adjustment on a three-point scale, these ratings being made by the principal of the school concerned (four schools being used in all). Details of the subjects are shown in Tables 1 and 2 of Appendix I.

4. The Analysis of Play-Behaviour

Assessments were made not of whole play-sessions but of the individual psychological units of behaviour into which these were subdivided. The subdivision was designed so that each unit of behaviour should be largely independent of those that preceded and followed, while there should be an intimate relationship between phases within each unit. Interruptions of one minute or less were ignored for this purpose.

The main assessment was that of organisation of behaviour. This was a composite 9-point scale of adaptiveness in the use of materials taken in conjunction with the degree of articulation and coherence shown in the play unit as a whole. The scale is presented in full in an appendix to this article.

Concentration was recorded at frequent intervals by the observer as the play proceeded, by making a marginal note: I = idle, A = average concentration, E = engrossed. Since these intervals were usually shorter than the play-units, the latter were assessed on a 5-point scale in which account was taken of fluctuations in concentration.

Co-operation was assessed on a 9-point scale based on those suggested by Van Alstyne (16) and Parten and Newhall (17):

1 Plays independently; takes no notice of other children.
2 Plays independently; some interaction.
3 Plays independently; takes considerable notice of others, e.g. talking to them and discussing their play.
4 Not playing; watching others.
5 Parallel play; little interaction (children playing side by side with similar materials).
6 Parallel play; considerable interaction.
7 Predominantly social behaviour, e.g. conversation (interrupting play).
8 A low degree of co-operation, e.g. two children co-operate on a task which could be done by one.
9 True co-operative play, e.g. dramatic role-taking.

Scales of combination of materials and of purposiveness of behaviour, thought at first to differ in emphasis from organisation, were found to correlate too highly to add materially to the total evaluation. Duration of attention was recorded for each child and each play-session by noting the duration in minutes of the longest play unit (in some cases, the longest related group of units).

5. VALIDITY OF THE PROCEDURES

(*a*) *Units of Behaviour*

The final subdivision of diary records into play-units was carried out entirely by the writer. To this extent, errors due to variation in viewpoint between several judges were absent. For 17 of the 22 subjects observed in the Research Centre, a preliminary subdivision was made by the observers, one for each subject. Discrepancies between these sub-divisions and those made by the writer arose mainly from the tendency for one judge to regard as two separate units an item judged to be one by the other. Some measure of agreement between judges may be obtained by the correlation between the number of units arrived at by the writer on the one hand and the 17 observers on the other. This proved to be ·75.

(*b*) *Organisation of Behaviour*

Each behaviour unit was copied on a card, yielding a total of some 1500 for the 22 subjects observed in the Research Centre. 159 of these cards were drawn in such a manner as to represent each play material in numbers roughly proportional to the number of times these were used. These were assessed independently by two judges. The degree of agreement between judges is given in the following figures:

Perfect agreement	64%
Agreement within 1 point	31%
Agreement within 2 points	5%
Disagreement of more than 2 points	0%

(on 9-point scale)

(*c*) *Co-operation*

Ratings on co-operation were made by the writer from the combined records of all observers. The final scale was developed at a comparatively late stage in the research, and no independent assessment was made on this scale. Earlier, however, assessments had been made involving only the categories of independent play, parallel play, low co-operation, true co-operation, watching and adult-oriented behaviour. Separate assessments by two judges on 163 unit cards showed agreement on 137 (84%).

6. RELIABILITY OF ASSESSMENTS

An estimate of the reliability of these assessments was obtained by finding the correlations between the separate sessions and applying the Spearman-Brown formula. Since it was intended that the fatigue and restricted material sessions should be experimental, the correlations for the smaller group of subjects are between the two control sessions. For the group observed in their schools, they are between the average of the first and third sessions and the average of the second and fourth.

22 SUBJECTS OBSERVED AT THE INSTITUTE

	Obtained	*Corrected*
Organisation of behaviour	·84	·92
Duration of longest unit group	·10	·19
Co-operation	·31	·48

41 SUBJECTS OBSERVED IN SCHOOLS

	Obtained	*Corrected*
Organisation of behaviour	·73	·84
Co-operation	·46	·63

The higher reliability of organisation of behaviour found with the smaller group of subjects probably reflects the greater age-range. Since co-operation varies less directly with age, the difference is reversed for co-operation, as the use of four sessions instead of two itself tends to produce greater reliability.

Reliability even of organisation of behaviour is lower than might be expected of a normative test. Reliabilities here indicate the extent to which the same child may be expected to show a similar level of behaviour on different occasions under conditions where he is free to do as he chooses. Judgments about an individual may well be unsafe unless based on 16-20 separate observations. If duration of attention is not required, these may well be shorter (i.e. 10-15 minutes). Perhaps the most important finding here is that organisation of behaviour appears to be the most reliable and consistent aspect of children's behaviour, while duration of attention (the main focus of study in the thirties) proves an unreliable guide.

7. Age and Sex Differences

TABLE I (22 subjects)

		Mean assessment (4 *sessions*)		
Mean Age of group	*N*	*Organisation of Behaviour*	*Co-operation*	*Duration of Attention*
2½	4	4·71	3·10	13·6
3½	6	5·45	4·99	12·3
4½	8	6·50	5·20	14·3
6	4	6·96	5·62	15·4

TABLE II (22 subjects)

Sex				
Boys	11	5·39	4·74	10·7
Girls	11	6·56	4·94	17·7

TABLE III (41 subjects)

Mean Age of Group				
3 yrs. 2 mths.	13	5·80	4·26	14·10
3 yrs. 9 mths.	13	6·24	5·01	14·03
4 yrs. 8 mths.	15	7·16	5·93	15·36

TABLE IV (41 subjects)

Sex				
Boys	22	6·37	5·32	14·30
Girls	19	6·52	4·86	14·81

Tables I and III bring out clearly the age trends in the organisation of behaviour. In view of the remarks on reliability in the previous section these cannot be taken as norms. However, the tendency for an even rise in organisation with increase in age is sufficiently clear. The figures from which these tables were drawn were tested by analysis of variance, taking into account variation in age and sex, and session-to-session variation. Owing to the small numbers involved, combined with the marked sex differences, age trends for the experimental group of subjects fell a little short of significance at the 5% level. Differences between the intermediate and upper age groups shown in Table III were significant at the 2% level.

The sex difference in the group of 22 subjects was very nearly significant at the 5% level. No such difference was anticipated. Its appearance should probably be attributed to the element of frustration involved in the experimental situation where boys were concerned. Although the play-room was well-equipped with a large variety of materials, the experimental conditions demanded that the children stay in the room instead of playing outside. Girls were not greatly hampered by this restriction since they were more often content to engage in elaborate dramatic play with domestic materials. Sex differences with the larger group were not significant. Differences between the two groups at corresponding ages are largely a function of the lower level of organisation in the play of many of the boys in the smaller group.

With regard to co-operation, age differences show a constant trend in both sets of observations although neither, taken by itself, showed significance at the 5% level. Analysis of variance brought out the high level of the sex-age interaction in the larger group. It would appear that variation between individuals of the same age and between the behaviour of the same individual on different occasions is greater than in the case of organisation of behaviour, as is borne out by the lower reliability of the scale.

As can be seen from the last column of the tables, results have been somewhat inconsistent on duration of attention. There is an irregular tendency for older children to spend more time in at least one activity but there is no even rise with age. It is clear from the results of previous work that the tendency is in fact consistent. The present largely negative results show that the duration of attention is subject to considerable fluctuations due in part to individual differences, but partly also to the particular activity engaged in (which explains the large sex difference obtained at the Institute) and the strength of interfering stimuli. It would follow that duration of attention, unless recorded over a very considerable number of sessions, is an unreliable guide to the maturity of play behaviour.

8. DIFFERENCES IN IQ

These differences were considered only in respect of organisation of behaviour, since this variable has most bearing on the study as a whole. Comparison of the correlations of organisation of behaviour with CA and MA is somewhat unsatisfactory since no allowance is made for the distribution of IQ between the ages. A more reliable indication may be obtained by comparing the mean performance of different IQ groups when allowance is made for the regression of score on CA.

Results for the 22 subjects observed at the Institute are presented separately for boys and girls to avoid confusion with sex differences (attributable to a variety of reasons and not wholly or mainly to the higher IQ of the 11 girls, as shown by analysis of co-variance).

TABLE V

MEAN SCORES (ORGANISATION OF BEHAVIOUR) OF 3 IQ GROUPS
EXPERIMENTAL SUBJECTS (GIRLS)

Mean Age of Sample 49·18 *months*

	N	*Mean IQ*	*Mean Score*	*Mean CA*	*Adjusted Mean Score*
Group A	3	137 (139-145)	6·98	45·0	7·31
Group B	5	121·6 (116-127)	6·76	47·2	6·92
Group C	3	99·6 (97-101)	7·19	55·6	6·60

TABLE VI

MEAN SCORES (ORGANISATION OF BEHAVIOUR) OF 2 IQ GROUPS
EXPERIMENTAL SUBJECTS (BOYS)

Mean Age of Sample 49·63 *months*

	N	*Mean IQ*	*Mean Score*	*Mean CA*	*Adjusted Mean Score*
Group A	4	113 (108-120)	6·12	56·25	5·80
Group B	7	99·14 (96-103)	5·13	45·86	5·31

TABLE VII

Mean Scores (Organisation of Behaviour) of 3 IQ Groups Schools Subjects

Mean Age of Sample 46·46 *months*

	N	*Mean IQ*	*Mean Score*	*Mean CA*	*Adjusted Mean Score*
Group A	13	125·77 (117-138)	6·40	44·69	6·53
Group B	15	108·60 (102-115)	6·62	48·6	6·46
Group C	13	91·08 (77-98)	6·27	45·69	6·32

Tables V, VI and VII show a consistent positive relationship between mean score and IQ. While none of the sets of results is significant, taken singly, their complete agreement is almost conclusive.

Barker, Dembo and Lewin (18) found the correlation of "constructiveness" to be the same with CA and MA and argue that constructiveness does not measure the same thing as the IQ, since it values imagination more and realism less. They did not allow for the age-distribution of IQ within their sample. Markey (19), who assessed "imaginative behaviour", obtained higher correlations with MA than with CA for every measure of such behaviour.

While it must be allowed that neither "constructiveness" nor "organisation of behaviour" are interchangeable concepts with IQ, the qualitative analysis of the development of behaviour suggests that a positive relationship is to be expected. That expectation is borne out by the consistency of the results here obtained. However, it should be stressed that "intelligence" is not the only factor in maturity of behaviour. Above all the high variability of this measure, even within the same individual, needs to be remembered.

Nor should it be forgotten that the predictive validity of the intelligence test itself is far from perfect, especially at this age level.

9. The Effect of Experimental Variation in the Situation

Table VIII shows the mean assessments obtained on four scales by the group of 22 children on each of four sessions. The first two of these are control sessions while the third and fourth represent behaviour under conditions of fatigue and restricted materials.

TABLE VIII

	*C*1	*C*2	*F*	*RM*
Organisation of Behaviour	6·27	6·15	5·58	5·89
Concentration	3·15	3·09	2·73	2·86
Co-operation	4·50	5·08	4·72	5·06
Duration of longest play sequence	15·36	14·45	13·0	12·68

While the mean assessments on organisation of behaviour and concentration and the duration of attention are on the average lower in the two experimental than in the control sessions, co-operation is not affected. In general, this finding is in line with expectation. But it should be stressed that the differences here recorded are far from significant and that individual variation was considerable. This was perhaps to be expected since in spite of the prolongation of the play period and the removal of materials, the experience of fatigue or frustration varied from case to case. In general, it was found that those children who showed the least concentration and the greatest liability to distraction (both measured separately) also showed the greatest fall-off in organisation of behaviour. In at least two cases, restriction of materials was accompanied not by frustration but by a fresh insight into the possibilities of the remaining material, giving rise to a higher level of play than was shown in the control sessions.

Of some special interest is the additional finding of much more active running about, particularly under the influence of fatigue. This result may seem somewhat paradoxical, although it accords well with the general experience of those who have the care of children towards the end of the day. It seems likely that the effects of fatigue are selective, and that the highest organising centres are particularly affected, while impulses to simple, though vigorous activity, previously held in check, are given full rein. This is the law of reciprocal induction as formulated by Pavlov (20).

10. SUMMARY

In the ceurse of detailed observations of young children at play, both in nursery schools and in a special experimental situation, a number of measures of play maturity were devised and tested. It was found that the best single measure of such maturity was the degree of organisation revealed in a child's play. The duration of play was found to be an unreliable guide. There was considerable evidence that play maturity and intelligence as measured by an individual test were not unrelated. In a subsequent article, it is hoped to devote some attention to a more qualitative consideration of the relations between cognitive growth and maturity of play.

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APPENDIX I

TABLE 1

22 Subjects observed at Institute of Education

Subject	*Age (mths.)*	*IQ*	*Remarks*
B1	30	103	Lives with own father and mother (not married). Four children of mother. Described as shy, placid.
B2	32	96	Mother separated. Youngest of three. Described as very serene and friendly.
B3	44	98	Middle of three. Family described as happy. Child shy, usually serene but easily upset.
B4	44	96	Child takes advantage at home, not at school. Mother ailing. One younger brother.
B5	45	100	Only child. Good home. Described as serene and contented.
B6	48	109	One older sister. Mother ailing. Child described as "typically boyish".
B7	51	120	Only child. Interested, bright, tires easily.
B8	54	108	Only sister grown up. Described as shy, over-mothered.
B9	56	100	Family of eight. Described as shy, rather secretive in behaviour, but sociable.
B10	70	101	Middle of three. Described as shy, boyish.
B11	72	115	Unmarried mother. Described as excitable, aggressive.
G1	26	97	Unmarried mother, only child, large family of adults living in house. Described as aggressive.
G2	32	121	Only child. Mother has TB. Described as happy, excitable.
G3	41	145	Has baby sister, of which perhaps rather jealous. Otherwise nothing outstanding.
G4	44	116	Mother separated, one younger sister, lives with grandmother, very shy.
G5	44	134	Youngest of large family. Described as helpful and friendly.
G6	50	132	Has one older sister. Described as tomboyish, rather excitable.
G7	51	125	Only child. Mother described as over-anxious, child as excitable, rather aggressive.
G8	54	119	Only child. Father in TB sanatorium. Described as serene, helpful.
G9	55	127	Only child. Shy, inclined to worry.
G10	71	101	One older brother. Described as shy, perhaps worried.
G11	73	101	Good home. Described as excitable and aggressive.

TABLE 2

41 SUBJECTS OBSERVED IN NURSERY SCHOOLS

Subject	*Age (mths.)*	*IQ*	*Adjustment*
B12	34	98	A
G12	35	117	C
B13	36	112	B
G13	36	77	A
G14	36	115	B
G14	37	118	B
G15	37	124	B
B15	37	80	B
B16	37	104	B
G16	38	92	A
B17	38	114	B
B18	38	98	B
B19	39	83	C
G17	42	138	A
G18	43	104	C
B20	44	114	C
G19 } twins	44	102	B
G20 }	44	118	A
G21	44	130	B
G22	45	130	B
B21	45	121	A
B22	46	132	A
G23	47	92	B
B23	47	137	A
B24	47	85	B
B25	47	120	A
G24	54	112	B
B26	54	95	C
B27	55	103	A
B28	55	117	C
G25	55	95	B
G26	55	97	A
B29	55	105	A
B30	56	97	C
G27	57	107	A
B31	57	112	A
B32	57	133	A
B33	58	95	C
G28	58	112	B
G29	58	103	A
G30	58	110	A

APPENDIX II

A SCALE OF ORGANISATION OF BEHAVIOUR FOR USE IN THE STUDY OF PLAY IN YOUNG CHILDREN

THE scale was devised in conjunction with a detailed investigation of the development of play behaviour in young children. The behaviour of the children was recorded in the form of a running commentary. Subsequently the accounts were divided into psychologically meaningful and coherent units, and these were separately assessed. The scale to be described showed a fairly high degree of reliability together with a reasonably close relationship to the ages of the children. It is reproduced here in full in the belief that it may prove of value both in the training of nursery teachers where some guide to their observations is often helpful, and in the work of teachers and principals in nursery schools when considering the progress of children in their charge. On the other hand, it should be stressed that the figures reproduced elsewhere in this article have no validity as norms, and that, in the opinion of the present writer, judgments based on such a scale can be valid for an individual only if he is observed on perhaps sixteen separate occasions, for periods of 10-15 minutes.

It was originally intended to assess behaviour units on two separate 5-point scales, the first concerned with the degree of adaptiveness in the use of materials, the second with the degree of integration of behaviour, with its level of complexity. In practice it was found that the two criteria were so nearly similar that they should be regarded as two aspects of the same quality, rather than as separate qualities. More precisely, it was found that a given level of integration presupposed at least an equivalent level of adaptiveness, though the reverse was not the case. By combining the two measures, it was thus possible to achieve a nine-point scale of organisation of behaviour. In every case, however, the final assessment was based on the total of two separate assessments on 5-point scales. These two scales were as follows:

(*a*) *Adaptiveness in the Use of Materials*

The interest here lay

(*a*) in the degree to which the child used the material in an appropriate manner, having regard to its properties and potentialities rather than indiscriminately;

(*b*) in the extent to which the child did not confine himself to the obvious treatment suggested by the material itself, but adapted it to conform with his own constructive or imaginative purpose.

Each unit was graded on a scale of 1-5 as follows:

1. The material is used without regard to its physical or representational properties in a manner recalling the play of infants.

e.g. He examines the material superficially.
He picks up a toy pistol, an iron, rake or a shovel, or a piece of waste wood and bangs it on the ground or on his own body.
He stirs the sand with his finger.

2. The material is used with some regard for its properties, but these are not exploited to the full. There is an element of lack of vision in the handling.

e.g. He shovels or rakes at the sand without making anything.
He clicks the toy pistol in an aimless kind of way.
He irons on the ironing board without any clothes on it and without connecting to the socket provided.
He hammers a brick without inserting a nail.
He daubs paint on paper or wood without any obvious representational intent, and without the intention of deliberately colouring it all over.
He makes a pile of bricks.

3. The material is used with regard to its properties, but in an obvious way. There is no coherent play theme which transcends the given materials, and within which their appropriate use figures as meaningful behaviour.

e.g. He fills the bucket, or makes a sand-pie without naming it.
He paints waste wood with the intention of colouring it, but without any further imaginative or constructive intent.
He pushes a vehicle all round the room, but does not use it to transport other articles, such as bricks or sand.
He puts the doll to bed in the cot provided, without extending the imaginative theme to other aspects of the domestic situation.
He irons clothes in a similar manner.
He makes plasticine "sausages".
He hammers a nail in wood.

4. The material is used in a manner transcending its merely obvious properties.

e.g. He builds an elaborate block structure.
He makes a recognisable human figure of plasticine.
He makes or attempts to make a sword or an aeroplane of waste wood.
He asks for a piece of wood to be sharpened to make a knife.
He uses a hammer as a tomahawk in a game of cowboys and Indians.

Or The material is used appropriately within the meaningful context of a larger imaginative whole.

e.g. He uses the dolly tea-set in the context of a fairly well organised tea-party.
He plays with the sand, giving a representation of a fish and chip shop.
He loads objects in a vehicle and carries them to a definite place.

5. The material is used in a highly insightful manner, adapted to a context which clearly transcends it.

e.g. He builds a "ship" on the sand-tray, inverting a table on it and wedging this with blankets, using the clothes horse as a ship's ladder, and so on.
He plays at a "tea-party" using sand as a birthday-cake, which he decorates, perhaps using small pieces of wood as candles, or perhaps wrapping small bits of plasticine in paper to make toffees, and so on.
He uses an orange box as a two-tiered bed for the dolls in domestic play, or as an oven to bake cakes (of sand or plasticine).
He uses paper, scissors and pencil in a game of "holiday booking-office", writing tickets which he cuts out and sells to his companions.

(*b*) *Integration of Behaviour*

This was designed as a measure of the complexity of the given behaviour. Since each unit constituted, as far as could be estimated, a psychological whole, such a unit could be simple, as when the child did some one thing, unrelated to the rest of his behaviour; or it could be complex, as when the child was engaged on an elaborate project. This classification approximated most closely in conception to that of "constructiveness" as defined by Lewin. There was a considerable overlap between "integration" and "adaptiveness in use of materials": the difference was one of emphasis. There the primary concern was with the treatment of the environment, here the main interest lay with the nature of the behaviour itself.

Each unit was graded on a scale of 1-5 as follows:

1. There is little or no integration. The subject seems to behave incoherently and achieves nothing definite.

e.g. He rakes or shovels at the sand aimlessly.
He moves a vehicle to and fro.
He examines a toy superficially.

2. There is integration at the level of routine behaviour. The child performs some simple task.

e.g. He loads bricks on a vehicle.
He plugs in the iron in the socket provided.
He fills a bucket with sand.
He tries to hammer a nail in a brick.
He paints a piece of wood.

3. A number of separate behaviours are integrated within the framework of a coherent task of some complexity.

e.g. He puts a doll in the cot and covers it over with blankets.
He tries to knock a sword together by driving a nail in two pieces of wood.

He fills and empties several vessels at the sand-tray representing a fish and chip shop.
He makes a sand-pie.
He paints a vehicle carefully inside and out.

4. There is integration of a high order. Several complex tasks are drawn together round a central theme, in a somewhat disjointed way.

e.g. He engages in domestic play, involving putting the children to bed, ironing clothes, and so on.
He builds an elaborate and representative boat with the multibuilder, selecting his pieces carefully. (Note that though only a single task is involved here, it is of a much higher order of complexity than those listed under score 3).
He has a game of skittles with another child, involving taking turns, knocking the skittles down and setting them up again.
He engages in a children's tea-party, involving laying the table, "eating", taking bucketsful of sand to the table and so on.

5. Well-knit and structured activity centring around a complex project which demands that the various sub-activities be carried out in a coherent sequence.

e.g. He empties all the sand toys from the sand-tray, and constructs a deck on it, using a table (to represent a ship); then fits it with ships' ladder, and so on, and plays at being a ship's captain.
He plays at a holiday booking office, involving cutting out tickets after he has written them, selling them to clients, demanding payment, etc.
He irons the doll's pyjamas, then changes her into them and puts her to bed.

THE COMPOSITE SCALE: ORGANISATION OF BEHAVIOUR

The above scales were not worked out on an *a priori* basis and subsequently applied to the behaviour records. The scales themselves were derived from a careful study of a random sample of records obtained. To achieve this it was necessary to prepare a card for each separate behaviour unit of the experimental records, of which there were some 1500 in all. The cards were then sorted out according to the type of activity engaged in and the material used, and sets dealing with the same type of material were carefully examined and graded. In the case of the experimental subjects all of the assessments were made from the cards in this manner, so that objectivity could be preserved and any halo effect eliminated. The assessments reached in this way were then transferred from the cards to the record sheets from which they had been taken.

A study of the examples given with the assessment scales shows that in general those units which were judged 3 on the scale of integration were rated either 3 or 4 on adaptiveness, those rating 4 on integration were rated either 4 or 5 on adaptiveness and so on. It was for this reason that the two scales combined yielded a better index of the level of behaviour reached than either taken by itself. What had been achieved was a device for rating a wide variety of behaviour on a single composite nine-point scale. In the interests of clarity, extracts from accounts of behaviour with the dolly's tea set are reproduced below. These have been selected so as to represent ascending levels of organisation, and the assessment on the combined scale is given against each item together with that on the scale of adaptiveness (A) and on the scale of integration (I).

Composite Assessment of Organisation of Behaviour

Examines cup.	2	(A1	I1)
Puts cup on floor in doll's corner.	3	(A2	I1)
Examines cup, spoon, pretends to drink, eat.	4	(A2	I2)
Pretends to eat from cup with spoon, asks another child for tea, pretends to drink, "pours" out more tea.	5	(A3	I2)
Pours out tea, then takes doll to adult, also tea-pot, pours a cup for adult, "fills" all the cups, without arranging these on saucers.	6	(A3	I3)
Lays table, neatly and correctly, pretends to put milk, sugar, tea through strainer in each cup.	6	(A3	I3)
Seats doll in place in corner, lays table correctly, tells doll to sit up. (Involving definite imaginative use of material not mere reproduction of obvious use).	7	(A4	I3)
Takes bucket of sand to table, spreads cloth, serves out, pretends to eat, then builds tower of bricks which she calls "big, big ice-cream", wraps plasticine and beads in paper, calling these "a new cake".	8	(A4	I4)
Takes shovelfuls of sand, places these under orange box which she uses as an oven saying: "They're big cakes". Brings cups and saucers to adults filled with sand, then returns to rearrange cakes in oven. (Though dominated by the idea of baking cakes for the dolls, she forgets the purpose of her efforts).	9	(A5	I4)
Shovels sand in cake tin, pounds it down. Takes to orange box, used as oven. Then pours out "tea", puts some cups of sand in the oven. She examines her cakes "to see if they're done", puts them out on the doll's table. Then takes the cups of sand from the oven and offers to adults together with plasticine on a plate which she calls "potatoes".	10	(A5	I5)

THE FUTURE OF GIRLS' GRAMMAR SCHOOLS

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1. INTRODUCTION

It is just one hundred years since Miss Beale became Lady Principal of Cheltenham Ladies' College, a position which she held for half a century. As Mrs Kamm reminds us in her biography *How Different from Us*, there were no efficient girls' schools until Miss Beale at Cheltenham and Miss Buss at the North London Collegiate School for Ladies proved that girls could be educated as well as their brothers. Their half-century of struggle has been followed by another fifty years, during which girls' grammar schools have been accepted as part of the pattern of our educational system and have evolved features of their own, different in many respects from the "ladies' colleges" of the nineteenth century, yet fundamentally derived from the standards and values established by Miss Beale and Miss Buss.

Probably Miss Beale was too busy educating herself, her staff and the general public, as well as her pupils, to consider what might be the position of girls' grammar schools in 1959, but with our wider experience, we may perhaps attempt to envisage some lines of development during the years ahead. Such a project may be regarded as a purely academic question by those who believe that the grammar schools are doomed, and that they will all be replaced within the next generation by comprehensive, bilateral, multilateral, or some other form of educational institution. The writer has lived long enough to see the growth, development and decay of many new types of schools (even in London and Birmingham) and cannot believe that a form of education rooted in the Middle Ages is likely to be completely submerged in England, with our strong sense of history and tradition. However, we are living in a rapidly changing world, the grammar schools have already changed profoundly in the post-war period, and they will undoubtedly change still further in the future as they adjust themselves to the needs of the coming generations.

The half-century which represented the régime of Miss Beale and Miss Buss saw the establishment of many girls' grammar schools by foundations both old and new. These schools formed the core of the grammar school system for girls and gave a pattern to the maintained grammar schools which followed in the next fifty years. It is possible that they may remain as the bulwark of grammar school education in the future. The post-war period has seen a great acceleration in the provision of new schools; Birmingham alone has brought seven new girls' grammar and technical schools into existence during the last decade, apart from other experimental schools. This expansion has been accompanied by a vigorous building programme.

In many respects the grammar schools for boys and for girls have developed similar characteristics; in fact many schools are co-educational and treat their boys and girls more or less alike. They have a common core curriculum, they all take the same examinations, they have similar standards and values, they attend the same conferences, compete for the same state scholarships and, to a certain extent, for the same places in the same universities. There are, however, certain differences in curriculum and emphasis and certain departures which may suggest lines of demarcation in the future.

In what respects have the grammar schools already adjusted themselves to the changing world?

Sir Richard Acland in his book *Why so Angry?* quotes a significant old Chinese curse, "May you live in interesting times!" Some would regard this experience rather as a blessing, for interesting times undoubtedly are a challenge and stimulus to life. The grammar schools have certainly lived through interesting times due to changes following the 1944 Education Act and the modifications of the School Certificate and General Certificate examinations.

Probably the greatest change is due to the remarkable growth of interest in education, and especially in secondary education, since the 1944 Act abolished all fees in maintained secondary schools. During the 1930's selection boards were disturbed by the high percentage of able children (especially girls) who refused offers of admission to grammar schools. To-day such boards are embarrassed by the large number of children seeking admission, while the number who refuse places offered is negligible. The result has been a remarkable rise in the status of the grammar school, especially as viewed through the rose-coloured spectacles of parents and children before admission is secured. This attitude has led to many problems involving the admission examination, the status of the secondary modern schools and the policy of political parties, and has even produced dramatic situations in very high places.

So high is the grammar school in the estimation of schools and parents, that it colours many aspects of school life. For example, the external examinations system is being adopted in the secondary modern schools; the departmental organisation, whereby one teacher is in charge of a particular subject, is now used widely in all secondary schools and has spread to junior and even infants' schools; the strength of parent-teacher associations in primary schools is due partly to the preoccupation with grammar school admission; the junior schools find great difficulty in resisting parental pressure upon the curriculum; while many schools have adopted a uniform which earlier was associated mainly with grammar schools.

One result of this great demand for grammar school places is that the schools themselves are probably the most democratic of our educational institutions, as has been pointed out in a recent pamphlet, *The Grammar Schools*, published by the Incorporated Association of Headmasters. They include a cross section of the great mass of society, with a few obvious exceptions, so that the daughter of a highly paid executive may be indistinguishable in class from the child of an unemployed workman. The opportunities offered them are the same and their success depends on personal factors, not upon social status.

2. The Sixth Form

Coincident with the general increase of interest in education has been the growth in the post-war child population, so that in addition to the provision of new schools, there has been a tendency to increase their size. Many more pupils now complete the main five-year course until the age of 16, and there has been a significant growth in the size of sixth forms. Fifty years ago my own sixth form consisted of four girls, now there are many schools in the country with sixth forms of a hundred or even more pupils.

The future must see the consolidation of this position, and provision should be made so that all the able pupils remain for two or three years in the sixth forms. At present far too many intelligent and capable young people are tempted to leave at 16 by the easy money of routine clerical work and by unprogressive posts in commerce and industry. The sixth forms prepare girls for entry into the professions, which are demanding higher academic and personal standards as well as increased numbers. The shortage of scientists and technologists is well known, both for industry and for teaching; the Minister of Education has recently announced that 12,000 additional places in teacher-training colleges are to be made available by 1962; there are thousands of additional places in the universities; there are increasing opportunities in an ever-widening range of careers; and this expansion must be met in the main by the products of the sixth forms. The wastage of good material at the age of 16 must be arrested, and positive measures will have to be taken, such as, for example, increased maintenance allowances for sixth formers; intensive campaigns to convince parents and children that it is essential to take the long view; and co-operation between educational authorities and employing bodies to secure that every child is educated to the limit of his capacity and that no child is prematurely taken into employment. In fact, there should be an end to the present *laisser-faire* attitude which allows the immature child to be the arbiter of his own future.

The grammar school of the next half-century, therefore, must be geared to the production of an efficient sixth form. The course should be envisaged as one of seven years and not as a combination of five for some pupils and five plus two for others. The grammar schools have developed the skills and techniques to provide the intellectual stimulus of specialist study in a wide range of subjects, together with a co-ordinated course of general study, hitherto largely unexamined, but now directly stimulated by at least one of the examining boards. Girls' schools have already made a significant contribution to this development of general interests as distinct from the narrower specialisation involved in Advanced Level studies and they will undoubtedly continue to stimulate their sixth formers to widen their understanding of the many living processes and problems in the changing world. In these courses Arts and Science specialists can work together to increase each other's skill and knowledge.

The sixth-form course coincides with a period of marked development in the adolescent, who is now able to study independently, to use the library wisely, to form balanced judgments, to formulate standards of intellect and ethics, and whose personality responds to opportunities for self-expression, for organising and administrating, for responsibility, and for making contacts with the outside world. The development of these abilities demands that the sixth former must be a member of a community of equal minds who act as a challenge to each other.

3. THE CURRICULUM

The grammar schools of this century have shown that they are living organisations in that they have widened their interests to meet the challenge of the times. Changes and modifications are continually being made; the curriculum is adapted to meet the needs of each generation, as one "year" requires a more intellectual stimulus and another a more technical bias. There has been in the girls' schools especially a growing recognition of the value of cultural subjects, such as music, drama and art, and of practical subjects, such as cookery and needlework. These subjects were almost unknown in grammar schools a generation ago; now an average sized school may well employ six or more full-time specialists in cultural and practical subjects. Many experiments are taking place in various types of grammar schools, which may be bilateral in their organisation, though no such quality is indicated in the name.

A subject which reflects very dramatically this process of adaptation is physical education. Dumb-bells and musical drill have given place to various systems, some indigenous and some derived from foreign countries. Each generation develops its own methods and techniques which are constantly changing in accordance with the philosophy of education and the needs of life in general. Rigid systems have been replaced by a new approach which develops a high degree of physical skill, but gives the pupil a stimulus to self-expression and individual freedom. Girls' gymnastics to-day have no relation to the regimental sergeant-major. Girls have developed their own games, netball, lacrosse, rounders, as well as hockey and tennis, and these now often form part of the class time-table, instead of being an extra on Wednesday afternoon! Swimming often plays an important part in the curriculum, while in dancing the girls' schools can be regarded as pioneers, with their practice of national and international dances, together with their special contribution of mime, rhythmic work, modern movement and free expression. It is not surprising that ballet and social dancing have become popular in our generation. The success of physical education in the curriculum is indicated by the sound physique and vigorous health of girls in the present generation.

The approach to English in girls' grammar schools also differs appreciably from its treatment in boys' schools. Many girls have a great love of reading, in fact, it is often a girl's chief leisure activity. They have a natural aptitude for literature which shows itself already at the primary school level. English is, therefore, an important subject in a girls' grammar school, with considerable numbers continuing its advanced study in the sixth form. Moreover, girls on the whole desire to speak well, so they respond to all forms of speech training—verse and prose speaking, choral speech and dramatic work. The latter is of great value in establishing poise in a girl, in developing her personality, in giving her a sense of responsibility. In a girls' school a dramatic production gives a stimulus to many departments since it requires, for example, costume-making and stage décor and lighting. In the same way, the school magazine is often a focus of interest, with original material and factual reports of a wider interest than a record of goals scored for or against!

Other general changes of emphasis are taking place in the curriculum of girls' grammar schools, with less insistence on the classics than formerly, and more emphasis on modern languages and science. These changes reflect the close link between the schools and the outside world. Interest in modern languages is linked with the general study of internationalism, and with the contacts possible to-day for young people of different nationalities to exchange correspondence and personal visits.

The position of science in girls' grammar schools is particularly difficult and poses one of the most vital problems for the future. Hitherto there has been a lack of balance between the Arts and Science sixths in girls' schools, to such an extent that it has become a vicious circle, with fewer science teachers producing fewer science students. The situation is so acute that many girls' schools are almost devoid of science mistresses. Many palliative measures have already been taken at various levels, but the position will deteriorate unless a national policy is formed and implemented, so that science departments of girls' grammar schools are efficiently staffed. The position with regard to mathematics teachers is rather similar.

The emphasis in the girls' schools has hitherto tended to be on the biological sciences. These are an obvious preparation for medicine, nursing and the ancillary medical services. But a much wider scope is promised to girls in technology, for which physics and mathematics are particularly required. The future should see girls as well as boys undertaking sandwich and other courses at the colleges of technology, while there is a need for more women science students at the universities if we are to produce the number of scientists required by the country. The urgency of producing more science and mathematics teachers for girls' grammar schools in the future is only too apparent.

4. CORPORATE AND CULTURAL LIFE

The widening process in grammar schools has been fostered in many other ways than through the curriculum, and this will certainly be the general trend of the future. The schools provide much of the cultural background of their members through activities outside the classroom. Most schools organise clubs either within or outside the school day; by suitable organisation it is possible to include some forty clubs, which cover a wide range of activity and interest, e.g. games, drama, music, art, crafts, science, internationalism, geography, languages, economics, etc. These give an opportunity for experiences outside the school walls, also for talks by experts from fields of work in the outside world. Many excursions are made from school to conferences and courses of all kinds, for example, to meetings of the Council for Education in World Citizenship, field study centres, Outward Bound schools, sixth-form conferences, theatres, concerts, art galleries, as well as visits abroad, particularly on an exchange basis. The concept of education as a "useful" service is largely giving way to the acceptance of education as a general training for life in a changing world. The girls are made aware of general problems such as those created by juvenile delinquency and by atomic developments, and of the many problems affecting people outside their own narrow circle: in the Middle East, beyond the Iron Curtain, and in multi-racial communities. The school's humanitarian philosophy can train them to give sympathy, understanding and help to all kinds of deprived people and "have-nots", independent of colour, race and creed. In this way the school helps to create and maintain ethical standards.

The English grammar school can usually be regarded as a social unit almost complete in itself. Its geographical position frequently necessitates the provision of a school dinner for the majority of its members who, therefore, spend the whole day in school. This has helped to condition the special conception of the school as an institution of general culture, and not merely one where the pupil receives lessons and then goes home. In this respect there is a marked contrast with schools on the Continent where there is often very little social life based on the school. This factor helps to give our schools their strong individuality of philosophy and atmosphere which is admired by our German colleagues. In many respects we have a great deal of freedom to develop our own organisation, curriculum, syllabus, attitudes and "isms". There is a wide recognition in this country that each school has its own needs and individuality, that the headmistress is a leader and not a figurehead, and that her personality can impinge upon the school in a marked degree, even if not so autocratically as in the case of Miss Beale and Miss Buss. The development of a unique community life is assisted by our practice of the daily assembly and by the social training involved in meals, out-of-school activities, school councils, prefect duties and in many other ways. The long school life of five to seven or eight years is also a great asset.

5. THE STAFF

One of the most significant changes in girls' grammar schools during the post-war period has been the composition of the staff. The acute shortage of teachers has opened the door to married women, who at one time were unknown in such schools. At the end of the first World War, married women were asked to resign. At the end of the 1939-45 War the schools would have ceased to function if a similar policy had been followed. This has led to a great deal of instability affecting girls' schools much more acutely than boys' schools. Women teachers no longer leave the school on marriage, but they do leave as the result of marriage—when they have children or when their husbands move to a different part of the country. This can cause serious interruptions in the education of the grammar school girl and can outweigh the advantage of having teachers with a rich experience of life as wives and mothers. The provision of teachers in the future should be sufficiently generous to make it possible for every girls' grammar school to have a nucleus of stable unmarried staff who can be expected to give continuity and to be sufficiently free from family duties to have time to maintain their own scholarship and to help in the process of widening and developing the girls in their charge. The whole question is tied up with the problem of the general shortage of teachers and is affected by the social change which causes women to marry at an earlier age than was the practice in former generations. At present it is all too common for the inexperienced graduate to join the staff as a married woman and to give a mere two years of service (sometimes less) before her family ties bring about her resignation.

A new feature in our girls' grammar schools is the inclusion of men on the staff—a practice which will probably grow in the future. For some years the practice has been dictated by the acute shortage of women scientists, and the schools are finding that there are many advantages in having men on the staff. From the professional point of view, there are certain dangers involved. There is already a strong tendency to make grammar schools co-educational, and in such cases a headmaster is usually appointed. It would be a severe professional blow to women if the proportion of men on the staff should ever justify the appointment of a man as head of a girls' grammar school.

6. The Responsibilities of the Grammar Schools

Certain changes are taking place in the society of the mid-twentieth century which present a special challenge to the grammar schools. We are living in the century of Ad-Mass, characterised by the easy thinking of the welfare state and mass culture, when the nation derives its knowledge, culture, opinions and attitudes from the passive reception of material presented by television, the press, the film and the glossies. The tendency is to accept uncritically all culture emanating from such mass machines, with a corresponding widespread apathy and ignorance among large numbers of people. Richard Hoggart has pointed out the dangers of such a situation in his *Uses of Literacy*. The grammar schools by their very nature should offer a strong resistance to Ad-Mass, by maintaining absolute standards of intellectual discipline, by encouraging independence of judgment, by establishing attitudes and ethics strong enough to resist the spurious and insincere, by inspiring a love of learning for its own sake, and by inducing a sense of responsibility towards the wider community of society and the world. All this must be linked with some positive and constructive thought, and in particular should act as a resistance to negative and passive inactivity both in leisure and in professional life. The girls' schools can create and foster such leisure pursuits as reading, needlework, drama, concerts and music making, dancing, ballet and intellectual hobbies, as well as discrimination in the selection of films and television programmes.

Social service of all kinds gives a positive approach to life and its many problems. Also girls' schools can do much to establish taste in dress, hair-styles, choice of furniture, home decoration, to enable girls to recognise beauty in everyday things, and to appreciate the arts of painting, sculpture and architecture. The schools can resist Ad-Mass by presenting a reasonable attitude to work, by inducing a love of study for its own sake and not merely for the sake of a General Certificate of Education, or a career or a high salary. This is perhaps one of our most difficult functions in a world dominated by materialism. Wise advice regarding the choice of a career is again a corrective to Ad-Mass. Since the late nineteenth century there has been a remarkable increase in the number of professions open to women.

We have seen the first woman doctor, surgeon, lawyer, engineer, architect, museum curator and Minister of Education. The range of opportunity for girls and women is likely to grow, and these careers are primarily for the sixth formers of our grammar schools. This emphasises once more the importance of saving the 16-year-olds from slipping into routine posts under the influence of all the forces of Ad-Mass.

The next half-century is bound to see many more changes in society and education, but I believe we are sufficiently resilient to adapt ourselves to the changes and at the same time to maintain our integrity. Certain specific modifications are indicated. The 1960's are likely to be a period of experimentation in an endeavour to remove the anomalies and weaknesses brought to light in the post-war organisation and practice of education. Each decade of the twentieth century has seen a vigorous swing of the pendulum in this country, and even more so in the two great countries to east and to west of us. Attempts have been made to implement implicitly the policy of equality, but however equal people may be, some are "more equal than others" in the degree of their abilities. No nation can afford to neglect the higher education of the intellectually able, particularly England with her dense population, who more than most countries must develop her academic and technological skills. Universities and colleges of technology can produce the trained minds, but the process of training must be started at lower levels. Upon the grammar schools depends not only this earlier preparation, but also the stimulus which will give the student the will to continue her studies in university and college. Only those who work in grammar schools realise how much is done in those last two or three years, not only to fit the girl to go on further, but also to direct her mind and will to aim at the highest of which she is capable. Experimenters in other countries are coming back to the inevitable need to give a special training to girls (and to boys, of course) with high ability. Our English experiments are likely to reveal their own deficiencies, for no system is perfect, so the grammar schools must maintain their resilience and adaptability in order to respond to the demands which will inevitably be made upon them. In particular, the foundation schools have an important rôle to play in maintaining independence, educational freedom and academic standards.

7. THE FUTURE: NEED FOR FLEXIBILITY

The process of adaptation involves many factors, all of which must show greater flexibility than has become the practice in recent years. The techniques of admission have become rigid and hardened, as they have been taken out of the hands of headmistresses and vested in education committees and administrators. Changes in procedure are already being made and more fundamental changes are envisaged. There should be much more flexibility in the transfer of children from one type of school to another, to fit their particular abilities. Some areas have worked out systems whereby this can be done, but in many areas such transfers are negligible or unknown. The late developer is too commonly ignored in our system, yet such boys and girls are numerically significant. Equally significant is the number of those who find themselves for various reasons misfits within the grammar schools. It should be possible to devise a system of two-way transfers which would obtain the support of both educators and parents.

Flexibility is also demanded within the schools themselves; curricula and syllabuses need to be constantly revised and modified according to the quality of the entrants; the Battle of the Subjects is evidence of the vitality of the schools; adjustment is necessary even within the same admission group, for the same curriculum is rarely suitable for all; contact with the outside world must be maintained, but ephemeral fashions and tendencies likely to lower standards must be resisted. The trend in recent years has been to raise academic standards by enlarging the examination syllabus and demanding a higher level of achievement. This pressure towards specialisation, especially in the sciences, can be counteracted by the flexibility of general courses. Girls' schools have already been pioneers in this development, and they are likely to progress still further in this direction in the future.

In many new schools, specialised rooms have already been provided to help the widening of the curriculum along modern lines. All grammar schools should possess facilities for developing the cultural, social and practical aspects of school life. Desiderata are an auditorium, large enough to seat the whole school in comfort (the United States and Sweden are both far ahead of us in this respect), a practical stage well equipped with curtains and lighting (many of the stages provided in new schools are much too large), a swimming bath (no real progress can be made in a bath shared with the general public), science laboratories and lecture room, art rooms, craft rooms, domestic science rooms, specialist rooms for such subjects as geography and music, gymnasia with changing rooms, a playing field on the school site, adequate dining accommodation, a medical unit—all these should be regarded as essentials in the future, though the majority of schools still lack them to-day.

The raising of the compulsory school leaving age to 16 will undoubtedly have repercussions upon the grammar schools, with still greater demands for higher standards of education. The future must also see an increase in the supply of teachers.

Finally, education is a living process, which aims at the training and development of the whole person, though the elements in man are so mixed that in an ideal system the emphasis would be different for each individual. It is for the schools to offer such a flexible pattern that every girl can receive the appropriate training to fit her to make the maximum contribution to society. Education must provide the right mingling of six elements for every child:

Intellectual, through the academic disciplines in Arts and Science.
Cultural, aesthetic, emotional, through art, music, literature and drama.
Practical, through craft, domestic science and needlework.
Physical, through gymnastics, games, swimming and dancing.
Social, through the school community, contact with the outside world and its problems, international, economic, humanitarian.
Spiritual, through Religious Instruction, the school's philosophy, its ethical standards, its attitude to life and work.

The girls' grammar schools of the last century (1859-1959) have proved that they are able to provide the setting for this living process, and in this way have widened enormously the scope and opportunities for women in the twentieth century. The future of women in society lies very largely in the hands of the girls' grammar schools of to-day and to-morrow.

COMPULSORY TRANSFER MEANS EARLY LEAVING

A NOTE ON "THE FUTURE OF THE GRAMMAR SCHOOL"

by F. SANDON

formerly Headmaster, Plymouth Corporation Grammar School

In Mr D. B. Gaskin's interesting article in the last issue of the *Educational Review* (XI, 1959, p. 101) he writes: ". . . nothing could be more likely to encourage early leaving than the need, if an advanced course is to be followed, to transfer to another school just at the age when the stirrings of independence and the attractions of high juvenile wages combine to tempt the boy or girl towards the adult world". I think that perhaps Mr Gaskin expresses a conclusion towards which he may first have been driven by something that came under his notice over twenty years ago. May I give some figures about the case in question?

In 1936 the Plymouth L.E.A. was responsible for two boys' grammar schools, three girls' grammar schools and one, the oldest of them all, a mixed grammar school. In the summer term of that year the City Council decided to close their mixed school at the end of the following school year. The city had its own minimum leaving age of 15, and a grammar school agreement age of 16. It was decided to transfer those pupils who wished it to one or other of the alternative grammar schools, and to cancel the age agreement. The school concerned had a two-form entry and the pupils varied in age, at the end of the third form, from just over 13 to just under 15 so that the statutory leaving age was reached between the summer holiday after the third form and the summary holiday just after the fifth form. The following table gives the experience:

Percentage of Pupils Leaving in Various Intervals

Sex	*Boys*					*Girls*				
Interval	III/IV	In IV	IV/V	In V	V/VI	III/VI	In IV	IV/V	In V	V/VI
Expected	4	6	7	14	40	7	12	24	16	43
Group A	*10*					*16*				
Group B	3	15	*28*			10	32	*29*		
Group C			14	17	*52*			32	25	*73*
Group D					83					75

When the decision to close the school was announced in the summer of 1936, Group A had just completed two years in the school, Group B three years, Group C four years and Group D five years. The table gives the percentages of pupils leaving at different stages in their school career from each of these groups, each percentage indicating the proportion of those on roll at the start of each interval who were not on roll at the end of that interval. Thus for Group D at the end of Form V there were 24 boys on roll and, of these, four only started after the summer holidays in a sixth form: the 20 who did not return give the 83% of the table. Similarly, among the girls of Group B, there were 25 on roll at the start of Form IV. During the school year 8 of these (i.e. 32%) left.

Figures in roman type indicate percentages of the four groups leaving between the announcement, in the summer of 1936, of intention to close the school and the actual closure in the summer of 1937. Italicised figures show the percentages leaving when the school was closed in 1937, and failing to re-appear in the schools to which they had been offered transfer.

The "expected" percentages are those based on the five years prior to those reviewed (in the case of the last three periods the records are not full enough for use and the percentages are based on figures of the last four years prior). The "expected" numbers going on to the sixth form over these years were 14 boys and 8 girls per annum.

In Group A, those pupils who were in the second form when the decision to close the school was announced, no children had then reached statutory leaving age. At the end of the year, however, the proportions of leavers were more than doubled and went up, in the case of the boys from 4% to 10%, and in the case of the girls from 7% to 16%, so that the numbers starting in the new schools were significantly less than had been planned.

Group B were finishing their third form work when the decision was announced. The only boy of statutory leaving age immediately left, and the fact that of all the 16 percentages given for the groups reviewed, this is the only one not greater than the expected, is clearly due to the fact that no more could have left at this stage. During their last year in the school these pupils, both boys and girls, left in much greater numbers than expected, many of the girls as soon as they reached the statutory age. In all, out of the two forms comprising Group B, only 17 boys and 12 girls were finally found in the schools to which they were intended to transfer.

Group C were in their fourth year when the decision was announced: they were the pupils due to take their School Certificate Examination in the last term of the school's life. Many of the boys did so, and then left, though many more of the girls than usual left during the year. The net effect was that there were few, either of boys or of girls, who were transferred to start on advanced work in a new school.

Group D were the worst hit of all. This group consisted of those who were in the fifth form when the decision was announced. They could therefore have had one year in their own sixth, but would have been transferred to another school after that. Only four boys and four girls decided to come back to their own school for that last year.

It was pointed out above that for each period the "expected" ratios are exceeded by each of the groups: 15 of the 16 percentages are greater than the "expected" figures, in some cases very considerably greater.

Mr Gaskin has not previously seen these figures. But I discussed the case with him at the time, for I was very closely associated with this interesting, but most unfortunate and cruel, experiment. I was the headmaster of the closed school and I was transferred with some of my boys to one of the other schools, one in which Mr Gaskin was a member of the staff. I have not the figures of the subsequent careers of my lost pupils after their transfer, but I know that several of them found the change of school so unacceptable that they left as soon as they could. Many found the difference between the happy family atmosphere of a well-run co-educational school and the less natural one of a one-sex school particularly hard to adapt to, so that the transfer effects may have been more pronounced than in cases where the schools are organised on less different lines. But data of this kind, for any wholesale attempted transfer, are so hard to come by that readers of Mr Gaskin's article might like to see what happened in this specific case. Mr Gaskin's proposition that compulsory transfer involves early leaving seems to be amply evidenced by the figures that I am able to supply here.

BOOK NOTICES

BOOKS ON THE ARTS

G. BAZIN, *Impressionist Paintings in the Louvre* (Thames and Hudson, London, 1958, 28s.).

G. BAZIN, *A Concise History of Art* (Thames and Hudson, London, 1958, 35s.).

Daily Express Art Treasures Book Club ("Daily Express", London, 1958, 15s.).

HERE are two well-produced books which should be in the libraries of secondary schools and colleges, and a series of reproductions worthy of hanging on the classroom walls.

M. Bazin has tackled two quite dissimilar tasks with great effectiveness. The first on Impressionism begins with a lively well-informed account of the struggles of impressionist painters against poverty and resistance from the museum élite and takes us to their final complete triumph and recognition in the Louvre collections. Some topical point is given to this account by the recent sale of seven impressionist paintings for a total of three-quarters of a million pounds.

The reasons for the long struggle faced by the impressionists are to be found in Bazin's summing up of the characteristics of the movement (p. 77). "Impressionist humanism," he writes, "is a really up-to-date humanism. . . . It shows humanity delivered from its ancient obsessions, both of religion and history, as well as of metaphysic. In the morning of the world, man goes forward joyously, with a smile on his face, drawn by the light."

But the second part of the book offers most directly to all secondary school pupils. A hundred full-page coloured illustrations of impressionist works from the Louvre bring the young reader face to face with the full force of the movement. First we are aware that the early impressionists were looking at different things from their contemporaries, even though their painting remained similar. Then we come to the full flood of impressionism in the painter's concern with light, colour and technique. Impression is seen not as a clearly delineated movement but as a spirit infusing a century of painting. There is a page of interesting comment opposite each picture.

Lastly the collection of 260 small monochrome reproductions provides a rapid over-view of individual painters' main interests and interpretations. If these are not so telling as the similar set of monochromes in the Thames and Hudson *Picasso* by Elgar, where the set is extremely effective, they round off the book adequately.

After reading this book and enjoying its pictures, it is to be hoped that secondary school readers who visit France will be stimulated to find their way to the Jeu de Paume. No reproductions can substitute for the originals.

M. Bazin's second task of providing a concise history of art in some 550 pages is indeed different—from a monograph to an encyclopaedia—but how well he does it! The story of art, architecture and aesthetic values is unfolded against their cultural and material backgrounds from paleolithic times. Not a corner of the world nor a period of artistic time escapes M. Bazin. Naturally in such a work with so many illustrations, the text has to be concise and may read in places a little dogmatic, but it is beautifully clear. Pupils will gain much from the pictures and from guided discussion of the text.

It is of some interest to the young British reader to see how a continental expert regards the English manifestations of the various changes in art and architecture, whether leading or following continental streams.

The *Art Treasures Book Club* run by the *Daily Express* has now issued a number of books each containing sixteen good, full-colour reproductions that capture the quality of the painting and texture of the originals in a very realistic way. As the reproductions are in suitable mounted form ready to be framed if so desired, the volumes represent a bargain at their price. The *Club* also sells frames to fit the mounts exactly at a reasonable rate, so that whether a school is interested in the material in book form or needs to add to the pictures on its walls, these books offer something very worthwhile. E. A. PEEL

BRIDGING THE GAP

ARTHUR KOESTLER, *The Sleepwalkers* (Hutchinson, London, 25s.).
L. W. H. HULL, *History and Philosophy of Science* (Longmans, London, 25s.).
A. NORMAN JEFFARES and M. BRYN DAVIES, *The Scientific Background—A Prose Anthology* (Pitman, London, 21s.).

THE sub-title of Mr·Koestler's book is *A history of man's changing vision of the Universe* and its contents are concerned mainly with the thought, life and work of astronomers, notably those who have most influenced cosmology like Pythagoras, Ptolemy, Copernicus, Kepler, Galileo and Newton. Such a brief description, however, conveys no indication of the power, scope and originality of the book.

The appearance of really original books in the broad field of the history of science is rare and Mr Koestler's essay in, what was for him, a new field is startling. Not that he was unprepared by training for such a venture and, having decided to set forth, he gave four years of study to the particular field he had chosen. His gifts as a writer and his human sympathy, working on much old and a good deal of new material, have combined to produce a book of intense interest and one which should give thought on the background of science a push in the right direction.

Many books on the history of science treat the subject as a linear progression from error towards truth, seeing the process of discovery from an eminence already attained. Other books tend to be a catalogue of discoveries in chronological order with little reference either to their influence or dependence on the prevailing intellectual climate. Mr Koestler's theme and treatment are in vivid contrast to both of these types. Sleepwalkers suffer from mental dissociation: there is an alternation of disconnected mental states. The victim of this disorder will in the day-time be quite unaware of his nocturnal escapades and, if told of them, may reject the evidence. In the book this figure is used with broad effect. In the author's opinion men of science suffer a similar disability, carrying simultaneously ideas about the universe which are rationally incompatible. For him "the Middle Ages were the era of the split mind *par excellence*"; there were certain mental obstacles to be removed which had arrested the progress of science "for an immeasurable time". They were: the splitting of the world into two spheres—the world of appearance and the world of reality; "the geocentric dogma, the blind eye turned on the promising line of thought which had started with the Pythagoreans and stopped abruptly with Aristarchus of Samos"; the dogma of astronomical motion in perfect circles; the early failure to bring mathematics to the service of science; and the wrong conception of motion and inertia.

All these ideas are treated in their place, their influence assessed, and their overthrow prepared for. In their treatment the reader is often brought up sharp by the colourful phrase or picturesque metaphor. For example, "from the twelfth century onwards the works, or fragments of works, of Archimedes and Hero of Alexandria, of Euclid, Aristotle, and Ptolemy, came floating into Christendom like pieces of phosphorescent flotsam". How apt this is.

Much of this book is taken up with the work of Copernicus, Kepler and Galileo. It is here that Mr Koestler projects his reader into the heart of the process of astronomical discovery. For a time we see Kepler as a man with physical hindrances, family encumbrances and mental limitations, quarrelling with Tycho and justifiably stealing his astronomical observations when he died. We share Galileo's quarrels with the Aristotelians and with the Church. We live in imagination with Canon Koppernigk on his remote rampart in Frauenburg. Such a method gives the reader an understanding of the times and a rare insight into the perils and difficulties of discovery.

To regard the details as mere local colour would be to misunderstand the purpose of the book. They are part of the matrix in which the discovered truths are embedded. The "tortuous progress" of thought influences and is influenced by social and family life and by the crystallised "wisdom" of the times. It would also be false merely to regard this book as the working over of old ground by a fresh mind; it is that, of course, but much more. It contains material which is new—this applies particularly to the work of Kepler—and free use is made, with copious notes, of primary sources. Most English readers, I presume to say, will have their eyes opened by Mr Koestler's treatment of Galileo's relations with the Church.

There are obvious disadvantages in the kind of treatment chosen for *The Sleepwalkers*. If we experience discovery in the raw, so to say, we sacrifice some of the elegance and clarity of the final picture. If we start with a framework of ideas we may feel that the facts do not always speak for themselves. But the present book should be of value to all who are interested in the physical structure of our universe, it should widen the horizon of many a sixth-former and university student and, as Professor Butterfield says in his Introduction, "it will be surprising if even those who are familiar with this subject do not often feel that here is a shower of rain where every drop has caught a gleam".

History and Philosophy of Science by Mr L. W. H. Hull has a more conventional approach to its subject. Its aim is entirely laudable: "To bridge the gap between science and humanities by considering scientific ideas in a context of history and philosophy." About two-thirds of the space is devoted to the various periods up to the nineteenth century; there is a chapter on *The Nineteenth Century and Evolution* and a short epilogue on *Twentieth Century Trends*. It will be seen immediately that the immense philosophic impact of twentieth century science receives no more than passing mention. It is, however, no part of a reviewer's task to tell the writer what sort of a book he should have written: these particulars are merely given to indicate the scope and emphasis in the present one.

The book may be warmly commended for its account of the early work in science; namely, the contributions of the Babylonians, and the Greeks in their various periods. In parenthesis, it will do a power of good if it reaches the writers of many elementary scientific books whose knowledge of the history of science is, to say the least, often tenuous and who tend to talk as though the Greeks were a compact group of people with homogeneous beliefs. The chapter on *The Middle Ages* is less satisfactory than those which precede it. That the early Middle Ages was a period of decline in science goes without saying but as a whole the period threw up some pregnant ideas for the philosophy of science. It is true, as the author says, that the early Christian Fathers, in some sense following St. Paul, turned from science because it was, in their opinion, tainted with paganism. It is also true that the influence of Plato was inimical to the experimental approach to knowledge and that Authority, particularly that of the Church, frowned upon new ideas when they seemed to conflict with the Bible. But to say that for a thousand years Authority had the better of the struggle with Reason is to oversimplify the intellectual flux of the times. The intellectual strivings of an epoch must be judged against the prevailing interests and the knowledge available at the time.

The author interprets much of his material in terms of "the struggle between Reason and Authority" and speaks of a second struggle within the ranks of Reason between empiricists on the one hand and upholders of the *a priori* method on the other. It is arguable that in the history of science this second struggle, so called, is the major one and that the central problem in our intellectual history is epistemological. One can, however, disagree with the author in this matter and yet enjoy and profit from the able way in which he handles his material and develops his theme.

There are a few minor criticisms to be made, apart from the inadequate treatment of the Middle Ages. It is scarcely true that the progress of science since the Renaissance has been a continuous evolution (p. 127) if by "continuous" is meant that there have been no gropings in blind alleys or delays through following the wrong tracks. Secondly, Francis Bacon's influence and his method might have received greater acknowledgment. After all he did arrive at the right notion about the nature of heat which on p. 208 is attributed to Locke's intuition. Thirdly, ought not Chapter 8 to be headed *Developments in the Seventeenth and Eighteenth Centuries*, as much of the material refers to the eighteenth century? Fourthly, to call Faraday an electrician jars on modern ears. But these are minor criticisms and they do little to detract from the book's obvious merits. One arresting phrase is worthy of putting on record. It is truly and succinctly said that "Humanism is the active confidence of men in their own powers".

The aim of *The Scientific Background* is also to bridge the gap between the sciences and the humanities. Professor Jeffares and Mr Bryn Davies begin their Introduction by saying that "the most pressing educational problem of the moment is how to remedy the broad divergence brought about by specialisation between the two main branches of knowledge, the sciences and the humanities". They point out that what we need above all is to find common ground for the teacher of science and the teacher of English, and that the study of the best scientific prose is a valuable starting point for any communication between arts and science. This standpoint seems unexceptionable and to translate their aim into practice they have chosen a wide range of extracts from scientific writings and a few from other fields.

The result is delightful. One hears about gravitation from Sir Isaac himself, we are told about radio-astronomy by Professor Lovell; Faraday discourses on the chemical history of a candle, Rumford on convection, Aldous Huxley on T. H.; we enter the Barrier Reef with Captain Cook, we watch birds with Julian Huxley and live in the Stone Age with Vilhjalmur Stefansson; William Harvey tells us how he discovered the circulation of the blood, Fowler and Samuel Johnson how to write and *Anon.* how to climb the turret of King's College Chapel.

This is a book to be savoured. There are a hundred extracts with questions on each, discreetly given at the end of the book, to test digestion. How far it will go towards bridging the gap is a moot point for the barrier of mathematics is a formidable one, not to be coaxed away by clear prose. Nowhere do I see an attempt to explain to the humanist the beauty and utility of, say, $\frac{d^2x}{dt^2}+\mu x=0$. Nonetheless the book is valuable within its field and most enjoyable.

All three books can be warmly recommended for sixth form reading and for training colleges. Each in its own way has a genuine contribution to make to the education of present day students whatever might be their major interests.

W. J. SPARROW

E. ASHBY, *Technology and the Academics* (Macmillan, London, 1958, 15s).

WHAT a practical bent Sir Eric's mind has could be ascertained from his earlier books, *Scientist in Russia* (Penguin), and from his direct solution of the question besetting the civic universities earlier this decade, that of residence and the lack of facilities. He suggested an interim remedy, which has paid handsomely ever since, wherever it has been tried: the "Ashby" scheme, in which the student stays in the union, sharing in the activities and having his evening meal there instead of in his digs, with a small reduction in his rent.

This small volume seeks to get to the bottom of another great difficulty, the gradual emergence and acknowledgment of technology as an academic subject. Since the days of Bruce Truscott no such inquiring mind has probed the problem indicated in the title, at least not in British universities. Sir Eric draws on the experience of Continental, especially German, *Technische Hochschulen* which sprang up parallel to universities and *because* the latter would at first not acknowledge science and especially technology as sufficiently "respectable".

The Swiss, German, Dutch and French experience with higher technological education had also moved men like Professor Oliphant, now back in Australia, to opt for a technological university or two over here, and the nascence of the colleges of advanced technology is largely due to pressure of men like these. Sir Eric gives also valuable literature references for further study of this problem and includes a plan for a kind of *studium generale* for institutes of higher technological education.

This book is addressed to a much wider circle than teachers, although they will derive most stimulation and benefit from reading it. Every industrial education and training officer, too, will find it a fund of information and suggestions.

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